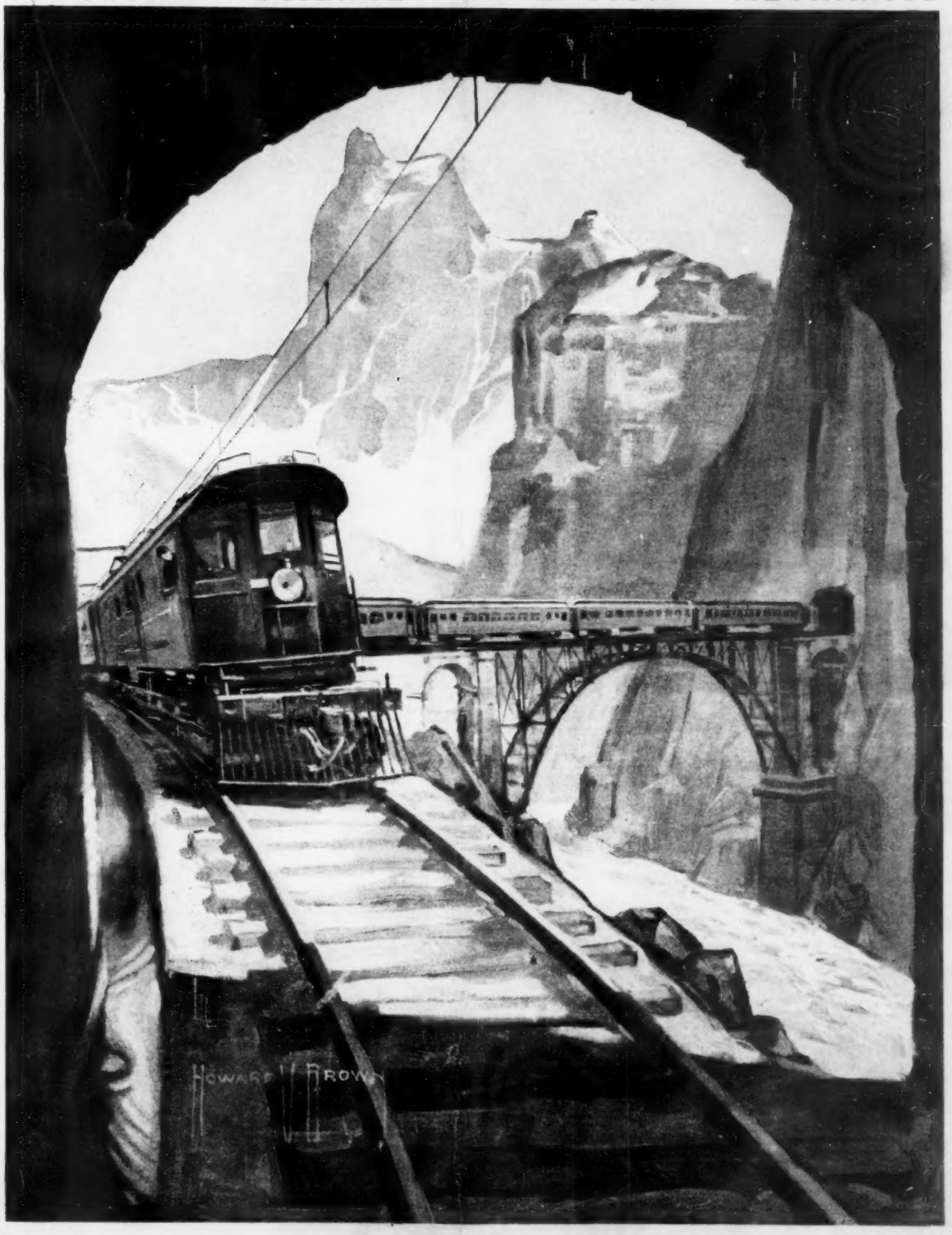
SCIENTIFIC AMERICAN

A Weekly Review of Progress in

INDUSTRY · SCIENCE · INVENTION · MECHANICS



ELECTRIC RAILROADING AT ITS BEST: CROSSING THE GREAT DIVIDE—[See page 243]

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The Product *of* Experience

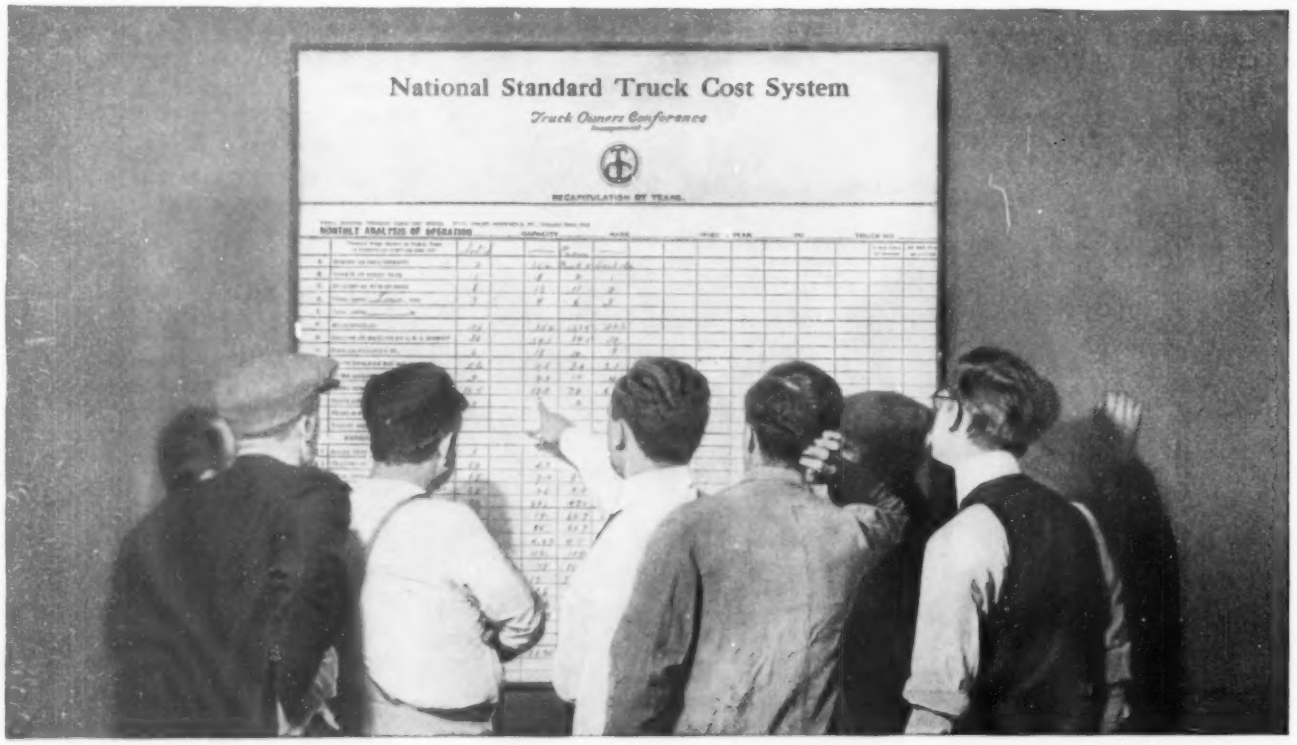
THERE is something which defies theory in the making of a successful truck. No blue print specifications can foretell its performance. Engineering skill alone cannot assure it.

The successful truck is the product of years of transportation experience under all operating conditions.

White Trucks have *grown* to be what they are. They do the most work for the least money because that has been the essential purpose in their development.

THE WHITE COMPANY, *Cleveland*

WHITE TRUCKS



Cost Keeping Instruction in the Truck Owners' Conference—a semi-formal association of Motor Truck Users. Its "National Standard Truck Cost System" is the first complete and impartial method for determining what each truck actually costs per ton-mile of transportation. Not only wages, gasoline, oil and tires—but repairs and replacements on his assembled trucks as compared with a truck built from the ground up as a homogeneous Engineering unit

Who Pays for High Costs

DR. LOUIS PASTEUR started to help the vine-growers of France. He ended by raising the health standards of the whole civilized world.

Every positive forward step brings benefits no man can foresee.

The merchant, the industrial man, starts to keep running costs on his trucks. Before he gets through he has searching figures on which trucks to keep and which to scrap—and what make of truck to put his money on in the future.

HERE are some facts, summarized from the National Standard Truck Cost System operating in 16 cities.

The following comparisons are between Packard and the ten other leading makes of trucks in these cities.

Packard Trucks show 10 per cent. lower *gasoline* costs than any other.

They show 30 per cent. *lower repair costs* than any other.

They show a *lower wage cost* per ton-mile transportation—make the trip in shorter time.

Ninety per cent. of all truck owners who have used the System for a year or more, and have compared the Packard with other trucks, have standardized on Packard.

TO get the full meaning of a record you must scrutinize the facts behind it—and the Organization that made the facts possible.

The Packard Organization has attained a precision in machine finish unknown elsewhere. It has achieved production of top-grade parts in quantity.

It has shown the world a radical advance in the improvement of metals by heat-treating.

It designs, tests and stands responsible for every part of every Packard Truck.

Even the Packard owner often finds it startling to see his advantages put down in cold figures—though he has known all about it in practice ever since 1906.

"Ask the Man Who Owns One"

PACKARD MOTOR CAR COMPANY, *Detroit*

SEVENTY-SIXTH YEAR

SCIENTIFIC AMERICAN

THE WEEKLY JOURNAL OF PRACTICAL INFORMATION

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A Year's Supply of Raw Material for the Melting Pot

By Ralph Howard

SUFFICIENT attention has hardly been given to the report, issued some little time ago by the Department of Commerce and Labor, showing the volume and the character of our immigration for the twelve months ending with June 30, 1919. As far as volume goes, to be sure, the showing can be dismissed with a word—inadequate, ridiculously inadequate. Intelligent estimate of this inadequacy can be gained only by a comparison with the period before the war. Over the ten years from 1905 to 1914, inclusive, our immigration ran in some years above the million mark and in others below; but the total for the decade was 10,100,000, with a few to spare. So the normal average after the twentieth century got really into its swing was at the rate of a million a year. For the three years 1915, 1916 and 1917 the war in Europe cut this average down to a bit in excess of 300,000; for the next two years, when American participation in the war restricted the ships even more mercilessly than the war itself had narrowed the supply of men, we received from abroad barely 125,000 persons per year.

With all manufacturing tremendously expanded to meet the accumulated demands, we would have liked, at the conclusion of the conflict, to jump back at once to a rate of immigration even exceeding the normal, if that were possible. Instead of that the year ending with June 1919, seven months of which fell in a state of *de facto* if not *de jure* peace, saw only 141,000 candidates for the kindly offices of the melting pot. Even without considering the great emigration from which we have suffered during and since the war, this figure is enough to establish the grounds of labor shortage.

The fact that the year's immigration is small, however, is no reason for not receiving it with gratitude, and examining its character with a view to ascertaining just what its value to us may be. The official statistician divides the immigrants into two major groups, the workers and those without any occupation. The latter head, it is to be presumed, for the most part represents the families and dependents of the persons catalogued in the first group. We have tried to indicate this state of affairs in our first drawing,

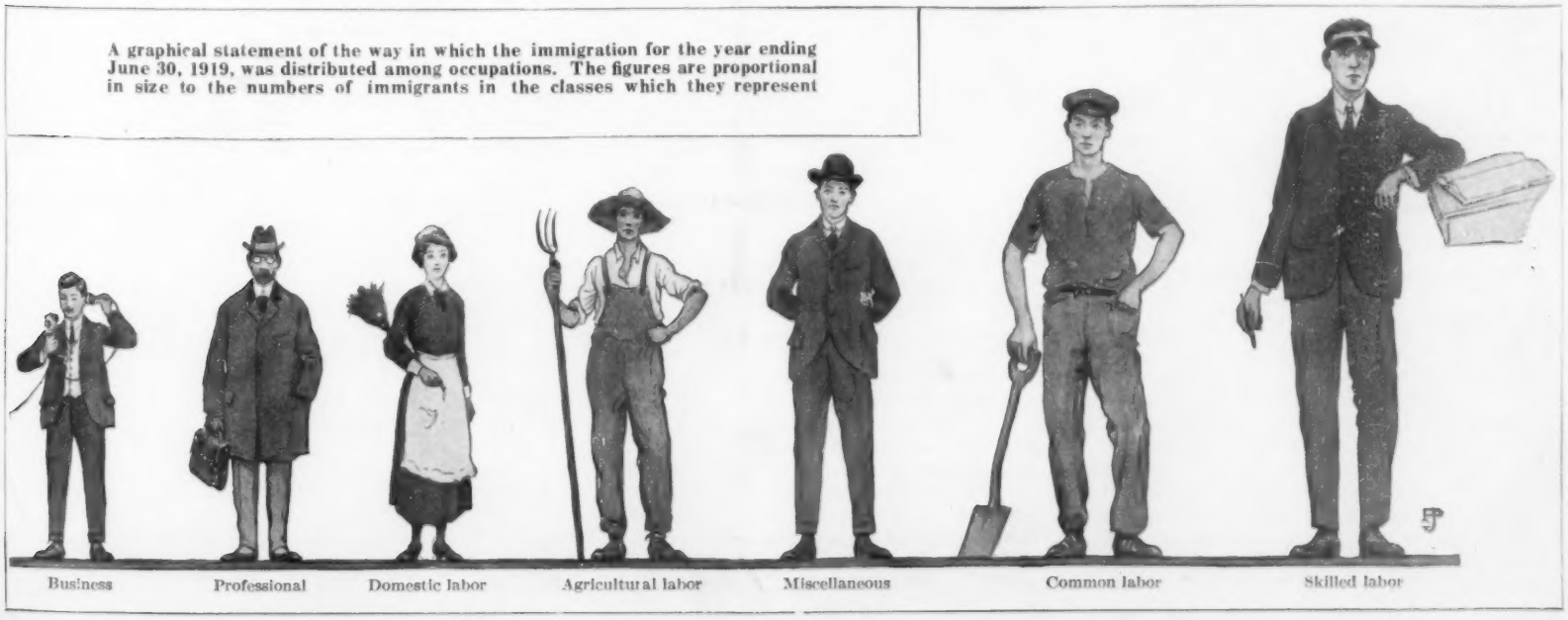
These two figures are so proportioned as to show the way in which the immigrants into the United States for the fiscal year 1919 were divided between workers and non-workers

in which the figure drawing pay at the cashier's window, and the figure of his "dependent" waiting to help him spend it, are in the proportion, as regards their sizes, of 82,818 to 58,314—the figures that we are given for workers and non-workers, respectively.

The Immigration Service goes further than this, analyzing the workers according to their occupations. The figures presented by the Bureau list 76 different occupations, and group these into three general heads of *Professional*, *Skilled*, and *Miscellaneous*. From the latter group we have singled out occupations which seem to us to come under the equally general headings of *Business*, *Agricultural Labor*, *Domestic Labor*, and *Common Labor*; and even this leaves still a residue of *Miscellaneous* callings. We then find that for these various classes the totals for the year are as follows: *Professional*, 6,272; *Business*, 4,131; *Skilled Labor*, 27,480; *Agricultural Labor*, 8,345; *Domestic Labor*, 6,277; *Common Labor*, 19,017; *Miscellaneous*, 11,296. On a percentage basis these figures represent, respectively, 7.6, 5.0, 33.2, 10.1, 7.6, 22.9 and 13.6 per cent of the total of workers.

One or two eccentricities of the governmental classification we have not eliminated—we had almost employed the less courteous term, "corrected." Clerks and accountants would no doubt be flattered in this year of grace to be included among the *Skilled Labor* aristocracy; but the individual clerk and accountant would doubtless point to his salary as conclusive proof of the fact that he is not quite in that class in point of reality. We would think that these men might more properly go in the *Business* group; and that a seamstress is more of a domestic helper than a skilled laborer. But, we have not changed the official classification, and as the clerks and accountants are the second most numerous occupation under the head of *Skilled Labor*, our artist has allowed them to stand for the group.

A graphical statement of the way in which the immigration for the year ending June 30, 1919, was distributed among occupations. The figures are proportional in size to the numbers of immigrants in the classes which they represent



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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

Wartime Bureaus and the Taxpayer

OUTSIDE of the regular bureaus of the Government, there has grown up of late years, and particularly since our entrance into the war, a great number of extra or auxiliary bureaus, commissions, committees and what-not. Now, although the reason for their existence has passed away, these organizations seem to be very reluctant to go out of commission. Anyone who returns to Washington after being there in war times and expects to find the city practically deserted by its wartime emergency, salary-drawing population, has a surprise awaiting him. The enormous temporary buildings which were rushed up to provide quarters for multitudinous bureaus are still there, and amazing to relate, they are, many of them, still quite populous.

There was never a time in the history of this country when there was a more insistent call for economy in the spending of Government funds, and if the taxpayers of the country knew how tenaciously many bureaus that have already outlived their usefulness are clinging to life, and the officials clinging for dear life to their salaries, there would be an instant demand on the part of the public for the Government to put in the pruning knife at once and with ruthless severity.

There was a time when Washington appeared to have simply gone mad on this subject of forming committees, commissions, etc., of one kind or another. Many of these efforts were given a "human interest" appeal by emphasizing the fact that they were more or less of an uplift or humanizing character, and the amount of propaganda that was spread abroad in the endeavor to emphasize their importance must surely have been contributory in no little degree to the present scarcity and high price of paper.

Far be it from us to be ungenerous or unjust. These bureaus were called for by the stress of war, and many of them did most excellent service; but the time of their usefulness is passed. The records which they have gathered should be properly card-indexed and laid away for future reference; but the bureaus, as such, should be closed, the staffs demobilized and the sums of money paid in salaries, which in the aggregate are enormous, should be saved to the United States Treasury.

The Need for Barge Canal Grain Elevators and Terminals

WHEN the Government, as one of the war measures, took over the New York State Barge Canal, it was hoped that this move would hasten by several years the development of canal traffic. Had the representatives of the Federal Government who had this section of our transportation systems under control wished to do so, they could have done much to repair the damage which the canals have suffered in the past years through unjust competition by the railroads.

But it was the policy of the Railroad Administration to make the best possible showing for the railroads, and in carrying out this policy, they did not hesitate to rob Peter in order to pay Paul. Not only was no vigorous effort made to restore to the canal that kind of traffic which was its legitimate share, but a policy of regulation of traffic was followed up which diverted to the railroads freight which otherwise would have sought the canal. This control, of course, was not nominally in force during 1919, but its influence is still being felt.

Another serious drawback has been the lack of canal boats, and this is explained by the fact that during the war, the building of new boats by private companies was practically impossible, the materials being so largely requisitioned for war purposes. Although conditions, as pointed out by State Engineer Frank M. Williams in his annual report to the legislature, have improved somewhat, still the high cost of labor and materials is holding back the building of canal barges. Another reason for the insufficient use of the canal is the lack of knowledge concerning both the canal and its advantages on the part of the public.

The greatest immediate need of the canal is a grain elevator at the port of New York, where the two existing elevators are owned by railroad companies. It follows, as naturally as the night follows the day, that these companies, competing with the canal for the grain traffic, will not allow the canal to use their elevators, and even if they were so inclined, their vessels are already insufficient for their own use. Consequently, such grain as now enters New York by canal, must, of necessity, lie in the barges which bring it until ships are ready to receive the cargoes. Now this tying up of boats which might otherwise be assisting to build up canal traffic is a condition which the State, for its own good, should hasten to remedy.

At Gowanus Bay, Brooklyn, an area for a large grain elevator has been prepared behind the new bulkhead wall, and the pier has been built in such a way as to accommodate suitable grain-carrying apparatus. We are quite in agreement with the Chief Engineer that an elevator with a working house and bin of ample capacity to meet the needs of the present and the near future, and so arranged that additional bins may be added as traffic increases, should be at once erected at this terminal. Fortunately, at Buffalo there is no actual lack of elevators, and boatmen are able to make satisfactory arrangement with the elevators' owners.

This question of grain elevators, we repeat, is the most urgent one in the whole Barge Canal problem. One hundred and fifty million dollars have been expended on this enterprise, and it would be poor business economy to handicap the canal and prevent its natural development by withholding the funds which are necessary for elevator construction.

The Beginnings of the Motor Car

WE accept the marvelous efficiency of the motor car as a matter of fact, and too often forget that as an example of swift development from crude beginnings to a perfected machine, the modern motor car stands unrivaled in the history of the mechanical arts. It is only some fifteen years ago that we were calling the new invention a "horseless carriage," and in those days who among us ever pictured the luxurious modern limousine car, with its speed of sixty miles an hour and its ability, if need be, to cover from 200 to 300 miles in a day's trip without even the thought of a mishap. We have before us an address by Dr. T. Blackwood Murray, delivered on his assuming the duties of President of the Institution of Engineers and Shipbuilders in Scotland. It so happens that he is the first president of that institution directly connected with the manufacture of light internal combustion engines, and consequently he devoted his address to a retrospect of the progress of the past twenty-five years in that particular field of mechanical engineering. The address, which is lengthy, will be published in full in an early issue of the SCIENTIFIC AMERICAN MONTHLY, and we purpose, just now, merely to dwell upon some of the leading facts brought out in his retrospective review.

It was thiry-five years ago that Gottlieb Daimler conceived the idea of building a light internal combustion engine for propelling a tricycle; and a few years later, Panhard and Levassor took up the manufacture and exhibited some of these engines at the 1889 Paris Exposition. The amazing thing is that these two men had evolved, twenty-five years ago, a vehicle which comprised almost all of the essential features of the standard motor car of today. The engine was mounted in front of the vehicle, under a bonnet, with its starting handle in front. There was a spring-actuated friction clutch, disengaged by a pedal for changing gear, which was done by sliding into mesh pairs of spur wheels, mounted on parallel shafts which gave three speeds and a reverse. There was a pedal-operated foot brake, and a second brake operated by a hand lever. The cooling water was circulated by a pump. All of these points are standard practice today. Although we accept them as a matter of course, everyone must agree with Dr. Murray that "we should realize what an enormous amount of thought and initiative must have been expended upon the problem of conceiving practical methods of applying the power of the Daimler engine to the propulsion of the road vehicle, and of inventing and designing suitable mechanism to accomplish these ends."

Levassor, in one prodigious stride produced a machine that was so practical that other engineers began to build similar motor cars driven by those Daimler engines or engines of similar design, and the trade had increased to such a point by 1894 that the *Petit Journal* organized a race between Paris and Rouen in which the Daimler engines easily carried off the leading place. The winning car weighed about 1,300 pounds, and was driven by an engine developing the enormous amount of three and one-half horse-power. That was one horse-power per 300 pounds of weight. Today, an average allowance for a passenger car is about one horse-power to 80 pounds of weight, and as a result of airplane engine development, it is reasonable to expect that the weight will, within a few years, come down to one horse-power to about 50 pounds of weight. This early Daimler was a two-cylinder engine with one impulse per revolution. It took a few years to bring in the four-cylinder engine with two equally-spaced impulses per revolution, and the four-cylinder car is still popular and covers a wide range of active service. Napier brought out the six-cylinder engine in 1903, and twelve years later the eight and twelve-cylinder cars were developed.

The early motors ran efficiently only at one speed and at approximately full load, for they were fitted with carburetors having no automatic regulation. Ignition was by means of hot tubes, and at any other speed or load than the one at which they were efficient, the mixture was either too rich or too poor to ignite with certainty. A study of the laws governing the flow of air and fuel led to the use of compensating devices which insured a proper mixture under all conditions, and simultaneously, the hot tube ignition gave way to the electric spark. Dr. Murray paid high tribute to the high tension magneto to which he pronounced to be "a marvelous achievement." It remained only for the automatic inlet valve to give way to the cam-operated valve, and for splash lubrication to be replaced by force lubrication and the modern automobile was complete.

The question of fuel economy is of vital interest to the users of cars both because of its affecting, as it does, the pocketbook, and the ability of the car to cover great distances on a moderate load of fuel. A survey of the field by this authority shows that the brake thermal-efficiencies of the various types of engines places the automobile motor in a "fairly satisfactory position." In the class of steam engines, the locomotive stands at the bottom with an average efficiency of 6 per cent, followed by the compound non-condensing engine, 10 per cent, the compound condensing engine, including boiler, 13 per cent, and the Parsons turbine, including the boiler, 17 per cent. When we come to the internal combustion engine, there is a decided jump. The automobile motor is credited with 23 per cent, the airplane motor with 27 per cent, the coal gas stationary engine with 30 per cent, and the average Diesel engine with 34 per cent. On reaching that modern development in which the internal combustion and the steam engine are combined, we get for the Still engine an efficiency (actually obtained) of 41 per cent, and Dr. Dawson sets down the probable future efficiency of the Still-Diesel combination at 44.5 per cent.

Electricity

Wireless Communication Between Sweden and U. S.—There has been a movement in Sweden for some time past for the erection of a wireless station which will be powerful enough to communicate with the world at large and with the United States particularly. Lately this project has taken on a very definite shape, and the Swedish High Commissioner, Mr. Axel Robert Nordvall, who was in Washington at the time of the war, is at the head of its promotion. The details have already been worked out and the whole matter handed to the Government of Sweden, which it is understood will present a request to the Swedish Parliament for the appropriation of $2,500,000 to be expended in the erection and equipment of this wireless station.

Color-Testing Equipment.—In a new electrical instrument the fading effect of sunlight is standardized and reproduced for testing the permanency of colors in textiles, wall papers, coloring materials, and so on. The new device consists of an arc using special electrodes and encased in two telescopic sheet-steel cylinders, the whole being mounted on a stand. The instrument, which may be used on either direct or alternating current, is said to consume about 2,800 watts and the life of the electrode is said to be about 20 hours. Provision is made for testing 40 samples at once. Part of each sample is covered and part is exposed to the light so that comparisons can be made between the tested and untested portions of the samples which are under inspection.

Vacuum Tubes Again.—In a recent article a leading telephone engineer has the following to say regarding the possibilities of the vacuum tube: "The results which have followed the researches made on and with the devices that have grown out of the improved DeForest audion indicates that in this instrument electrical engineers and scientists have a most potent tool for advancing the art not only in the communication field but elsewhere. While many new and important uses employing the principles involved in the audion have been developed, the limits to the extent of its applicability are not yet in sight. It is probable that at no time in the world's history have so many physicists been engaged in a single piece of work as are now involved in the study of thermionic problems."

Stavanger Radio Station.—The Stavanger wireless station began to send messages on December 13, 1919, the official opening having taken place on December 6th. The station will receive and send telegrams for Norway, Sweden and Denmark. The rates will be the same for these three countries and considerably lower than those which are in force at present. Cable telegrams have up to the present cost 1.30 crowns ($0.35) per word; the price by Stavanger wireless will be 0.90 ($0.24) per word. The dispatch of messages to America is so arranged that telegrams are sent by the ordinary lines to Stavanger, also from Sweden and Denmark. Stavanger is connected with the American continent by the Navy Department's two stations at New Brunswick and Annapolis. The two stations, Sayville and Tuckerton, which have been in operation for several years, can also be used.

When Iron Gets Sick.—In a recent issue of *Elektrotechnik und Maschinenbau*, M. Vidmar draws attention to the disastrous effects that may arise from iron filings when, through carelessness in construction, they exist in cavities in the iron cores of electrical machinery. In large units considerable voltages (of the order of a few tenths of a volt) may occur between neighboring plates or other parts. If iron filings or chains of filings bridge across such places, very high local temperatures may obtain through development of Joulean heat—0.2 volt would suffice to heat an iron particle to 1,000 deg. C. inside a fraction of a second. A burn may result where the insulation between laminae is destroyed. The local losses then increase, and break down follows in severe cases. In investigating certain cases of transformer burnouts the author found in the cores big lumps of solidified iron filings, forming welds across bundles of plates. This leads to the conclusion that iron-sickness was the cause of these premature break-downs.

Science

The Journal of General Physiology, just launched by the Rockefeller Institute for Medical Research, 66th St. and Avenue A, New York City, is intended to serve as an organ for the publication of papers devoted to the investigation of life processes from the physiochemical point of view. It is to appear bi-monthly. The editors are Dr. Jacques Loeb, of the Rockefeller Institute, and Prof. W. J. V. Osterhout of Harvard University.

An American Meteorological Society is to be organized at the St. Louis meeting of the American Association for the Advancement of Science in December, 1919. No national meteorological society has heretofore existed in this country, the nearest approach to one having been the New England Meteorological Society, which ceased to exist many years ago. The Weather Bureau has, however, to some extent taken the place of a national society, especially in former years, when its officials held conventions from time to time. The new society will probably utilize the *Monthly Weather Review*, the organ of the Weather Bureau, as its principal medium of publication, but will also issue a periodical leaflet or small bulletin.

Federal Inspection of Horse Meat.—In accordance with an act of Congress passed July 24, 1919, the U. S. Department of Agriculture has undertaken the inspection of horse meat and horse meat products intended for interstate or foreign shipment. Regulations have been adopted providing for the proper labelling of such meat and products, for slaughtering and preparation in establishments separate from those in which other animals are killed and handled, and for the condemnation of diseased horses. It is expected that this measure will help to relieve the shortage of meat and leather at home and abroad, besides providing an outlet for disposing of inferior horses, especially the small horses—many of them wild—of the western ranges.

The First Living Okapi Ever Seen in Europe, and the only specimen of this animal kept anywhere in captivity, reached Belgium from the Belgian Congo last August and is now the crowning attraction of the Antwerp Zoölogical Garden, where its habits will be studied with great interest by naturalists. Surprisingly little has been learned about okapis, since the discovery of this member of the giraffe family by Sir Harry Johnston in 1899. The present specimen was captured when only a day or two old, and was raised with great difficulty by Mme. Landeghem, wife of the Belgian commandant of the district of the Bas-Uelé, who for several months devoted herself assiduously to the task of securing the proper food for it. It was presented to the Antwerp "Zoo" by M. Landeghem.

Methods of Studying Atmospheric Dust.—A recent critical review of the methods used in studying the dust content of air, by Dr. Henry F. Smyth, of the University of Pennsylvania, leads to the following conclusions: No single method of air sampling for dust content yet devised is ideal, but several are particularly adapted to special conditions and have distinct fields of usefulness. In studying industrial dusts sampling should cover sufficient intervals of time to allow for normal variations in dust production and distribution, and collections should be made as nearly as possible from the working level. With dusts containing poisonous substances, samples must be large enough to permit of accurate chemical tests. For complete studies and for fixing permissible limits of dustiness, tests must permit of estimating weights and counts and determinations of the physical and chemical nature and size of dust particles. These tests are at present best and most easily made on samples collected with the apparatus devised by G. T. Palmer (*American Journal of Public Health*, 1916, p. 54), though sugar filter samples treated according to the technique described by Muir and Johnson in the "Report of the Miners' Phthisis Prevention Committee of the Union of South Africa" (1916) give as much information. Other valuable tests include colorimetric tests with cloth screens, the Hill capsules and pump, the Aitken dust-counter, the Duckering cotton filter, and the precipitation method of G. C. and M. C. Whipple.

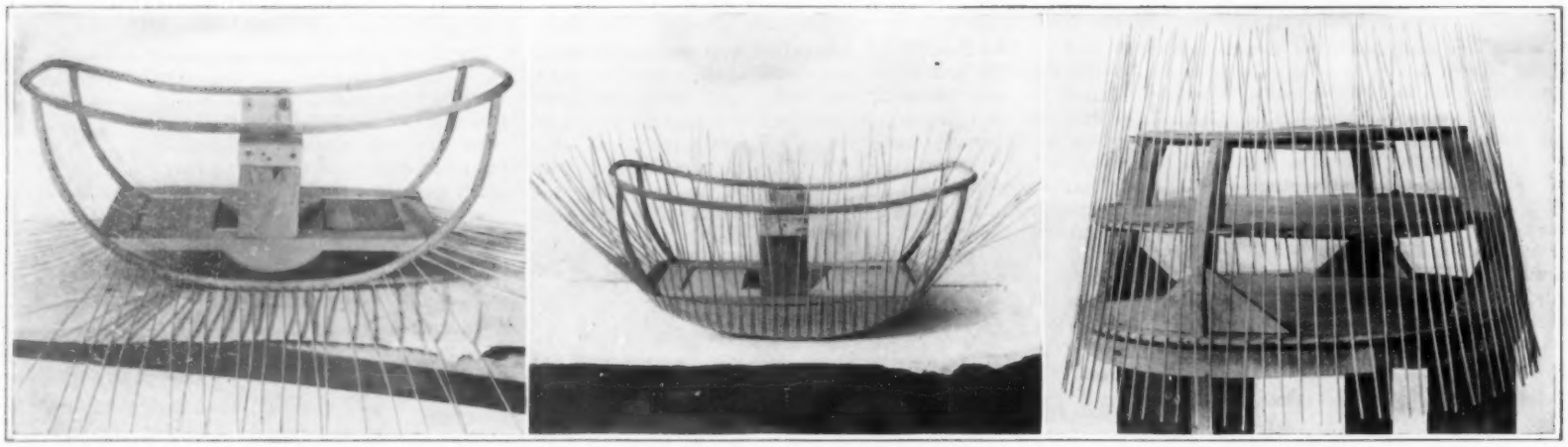
Automobile

Motorizing Fire Departments.—How rapidly the public service departments of American cities are being motorized is not fully realized. New York, Boston, Chicago, Cincinnati; in fact, nearly all the large cities are fast approaching the point where horse equipment will be no more. Smaller cities are adopting the more efficient service of the motor apparatus to a most encouraging degree. When one considers the numerous advantages of motorized apparatus which is faster and more economical than horse drawn fire extinguishing equipment, it is evident that the progressive communities in our country will purchase more and more equipment of this nature as appropriations are made and become available for the purpose.

Concrete Tracks for Roads.—One of the suggestions put forward recently is that the wear and tear on soft road surfaces might be relieved by the construction of concrete wheel tracks laid on or by the side of the existing roads. It has been recommended that a stretch of road at some suitable point be laid with an experimental concrete wheel track on which tests could be carried out. There have already been constructed in several districts in England wheel tracks of special wear resisting material and, while it is asserted that they doubtless save the rest of the road surface from wear, they are open to objection because they not only involve a considerable initial expenditure, but also require a good deal of attention subsequently to insure that the edges of the tracks are kept approximately level with the adjoining road material to secure level surfaces.

Pneumatic Tires on Trucks Carrying Material.—The rapidly increasing use of pneumatic tires on motor trucks rendering service on many big ranches of the Pacific Coast section is emphasized and their advantages in some uses are well brought out in the case of the Lone Pine Ranch, near Loomis, California. This tract includes 90 acres of fruit trees. During the fruit season many trips are made each day, delivering fruit over a six-mile route to the railroad by a two-ton truck, equipped all around with pneumatic tires. A year's experience in using pneumatics in this service shows that the fruit hauled has been practically free from bruising, thereby saving many dollars and that many more trips can be made in a day than were possible before pneumatic tire equipment was installed. The truck is run over the rough ground in the orchard, picking up the packed fruit, yet in a year's time it has run 3,000 miles without repairs to the truck or removal of a tire from the rim. An average of 14 miles to the gallon of gasoline has been established. There is no doubt about the value of air-filled tires when medium weight loads of fragile or perishable materials are to be carried or when high delivery speeds are called for. For many classes of work, however, the solid rubber tires are more economical and entirely satisfactory.

Decline in Wagon Building.—The member of a firm formerly prominent in selling horse-drawn vehicles on the Pacific Coast gave some interesting figures showing how the carriage and wagon builders have lost business due to the inroads of the automotive industry in the transportation field. It seems that there were 14,000 buggies sold in Los Angeles County alone in 1896 and 6,500 wagons. Two years later the first automobile appeared and business thereafter declined steadily. It is doubtful if 100 buggies a year are sold now in California. Salesmen working in rural districts used to sell an average of two buggies a day and more sets of harness. One prominent wagon builder sold $8,000,000 worth of horse-drawn vehicles in 1896. In 1905 they stopped manufacturing them and concentrated their production facilities on automobiles which they had gradually developed as their wagon trade decreased. Not all firms were so foresighted or fortunate, however, and many factories that formerly manufactured thousands of horse-drawn vehicles are but a memory. Most wagon builders of progressive mind installed automobile departments and are now reaping a harvest as manufacturers of special truck and van bodies to be fitted to standard automobile truck chassis, work for which their mechanical equipment, working forces and experience are particularly well adapted.



Left: The frame with the weft in position for hand weaving, ready for the weaver to interlace the warp. *Center:* The progress here shown in the weaving of the warp is the result of 45 minutes labor. *Right:* Arrangement of the weft for semi-machine weaving, in which shaping follows instead of precedes the placing of the warp.

Stages in the operation of basket weaving by the methods in vogue before the invention of machinery for doing this work

Wicker-Weaving by Machine

How a Manual Art of Five Thousand Years' Standing Has Succumbed to Mechanical Methods

By George W. Rowell, Jr.

IT is hard to believe that in all these ages of industrial advancement, since the coming of man, there could be one art handed down without change from generation to generation. And yet that is just what has happened in the wicker weaving line. Century after century has found this ancient art handed down and down and down without development. Many tried to improve it and failed, until it became an accepted fact that the method of producing wicker goods was a supreme gift to mankind and that no improvements were possible. Today it is being improved.—THE EDITOR.

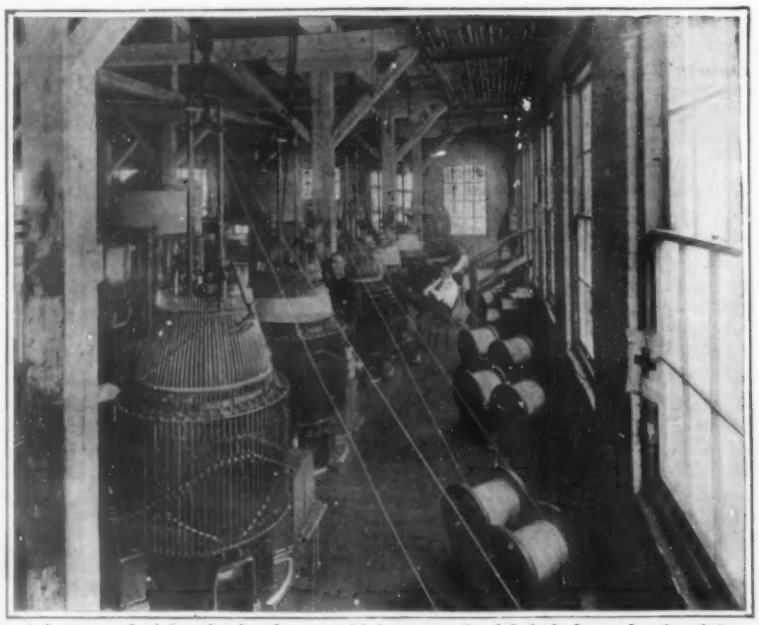
JUST as the early man made his shelter by sticking upright stakes in the ground and weaving branches between them so were baskets and furniture made by sticking the upright stakes or weft in holes bored into the frame and then weaving the warp in and out, shaping the fabric as it was woven to the frame. Thus also has the modern weaver worked in producing baskets, furniture or baby carriages—the three greatest wicker-woven articles.

This intertwining or weaving of the warp through the weft was always done by hand. Through the natural imperfection of man no two articles were ever just alike. Hence, a wide variety was produced without uniformity—a detail of the greatest importance in modern times. Several men attempted to build looms which would weave wicker but the very fact that the fabric had to be woven on and shaped to a frame in one operation halted every attempt. In fact no genius was able to produce a weaving machine of any kind—textile or wicker—which would weave in irregular contour. The nearest approach was a machine which wove circular textiles but which was never developed beyond that narrow sphere.

Many years ago manufacturers assumed the positive position that wicker weaving was an art which could not be improved upon and an art for only human hands to perform. Hence, information shows little or no modern attempt to create a machine which would do the work. It now seems that the difficulty in the way and the reason for so many failures was that all who attacked the problem attempted to use the Biblical method of attaching the weft to the frame of the desired article, and *then* interlacing the warp. This is all right with cloth, with wicker it can't be done.

This was the state of the wicker-weaving industry when Marshall B. Lloyd of Menominee, Mich., turned his attention to it. He had behind him a record as a successful inventor, having started in this field when little more than a boy, with a combination bag-holder and scales enabling one man to weigh sacks of grain, in place of the customary two men. Then he developed a machine for weaving wire bedsprings, and made this a financial success. This was followed by an invention of a process for making thin-gage steel tubing at a great saving. Finally, being a manufacturer of baby carriages among other things, he was attracted to the wicker-weaving problem by the great length of time consumed in weaving wickers for his carriages. It was all hand work, actually requiring one day for a skilled weaver to weave one baby-carriage body. Facing the fact that other men had vainly attempted to build looms which would weave the fabric, but aided by his helpful experience of having made steel-wire-weaving machines which had also been considered impossible, Mr. Lloyd set out to work.

From the very first he realized that no loom could be built to weave wicker if the original and only known method of weaving on the frame in the final shape were used. But unlike so many others, he had the imagination to seek a new method. Finally it came and Mr. Lloyd produced a method whereby the wicker is woven as desired, and the frames are built according to patterns, absolutely independently. The one is constructed at one end of the factory and the other is woven at another end. Each is improved as it travels toward the middle where the fabric is slipped over the frame and attached thereto. Simple indeed, and yet never thought of before. No man ever dreamed he could weave the wicker and build the frame of the desired article apart from each other and yet that is just what is now done.



A battery of wicker-basket looms which weave the fabric independently of the frame, bringing them together later

The weavers were first given patterns to which they attached the weft. The latter were bent on the pattern in accordance with the article desired so that the weaver was not compelled as under the old method to shape his fabric as he wove. This greatly improved the situation and speeded up the work but Mr. Lloyd was still bent on weaving by machinery. This had been a dream of years on his part and the failures of others did not alter his ambitions one whit.

After many failures he produced a loom. It is really a small circular machine which like many other big things does not appear to be nearly as important as it is. The weft is attached at both ends so that the rest of it bends in accordance with the shape of the loom. Then the loom is operated in rotary manner.

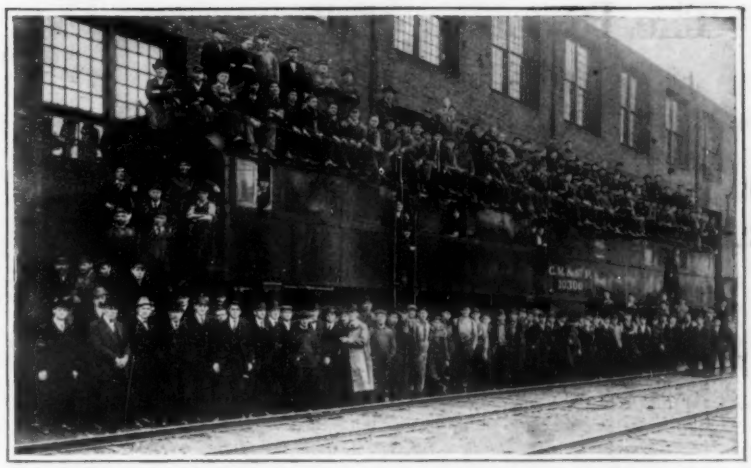
The wicker, wrapped in spools at the side of the loom, is threaded into it over a tension wheel. Before starting the loom in its rotary movement the stakes or weft are placed in permanent positions much as they are fitted on to the patterns when the Lloyd Method is used for hand weaving. Both ends of the weft are fastened before the loom begins to operate. As the machine revolves the warp is drawn from the spools on each side over the tension wheel and into the stationary shuttles, there being two weaving devices on each loom. A star shaped wheel meets the weft as it turns on the loom and just before it reaches the shuttle the wheel presses alternate strands to either side of the shuttle. After the warp is drawn through the shuttle and woven, an automatic finger attached to a flexible arm grasps the warp and presses it downward to its proper place. Each arm has a uniform weight attached to it so that the weaving must necessarily be even. These weights travel on a stationary cam and operate uniformly at all times. The arm with a small wheel shown at the front of the loom holds the weft in shape while it passes over or behind the shuttle. The machine is extremely simple, can be operated by an ordinary man with no skill required and weaves just thirty times more fabric than the best hand expert can weave. When the body has been woven the top of the machine is raised and the article taken off. The top and bottom ends of the weft are bent over by hand and the carriage body is completed.

Electric Locomotives That Are Still Larger and More Powerful

By William H. Easton

THE main reason why electricity is superior to steam for operating railroads lies in the fact that much more power can be applied to a train when electricity is used than is possible with steam operation.

The limit in the size of the steam engine—which is restricted mainly by clearances—has been reached at around 3,000 horse-power, but much more powerful electric locomotives have already been built and their maximum capacity is not yet in sight. Indeed there is no reason why as high as 50,000 h.p. cannot be used for train operation when electricity is used. With more power per train, heavier trains can be operated at higher speeds and thus the traffic capacity of a given railroad can be greatly increased without a proportionate increase in expenses.



At the present writing this electric locomotive is the world's largest, but for how long will it remain so?

The tendency is, therefore, towards larger and larger electric locomotives. For some time past, almost every year has seen "the largest locomotive in the world" produced and it is probable that this pace will be kept up for some time to come. But this means progress and is the best of evidence that the railroads have no intention of standing still.

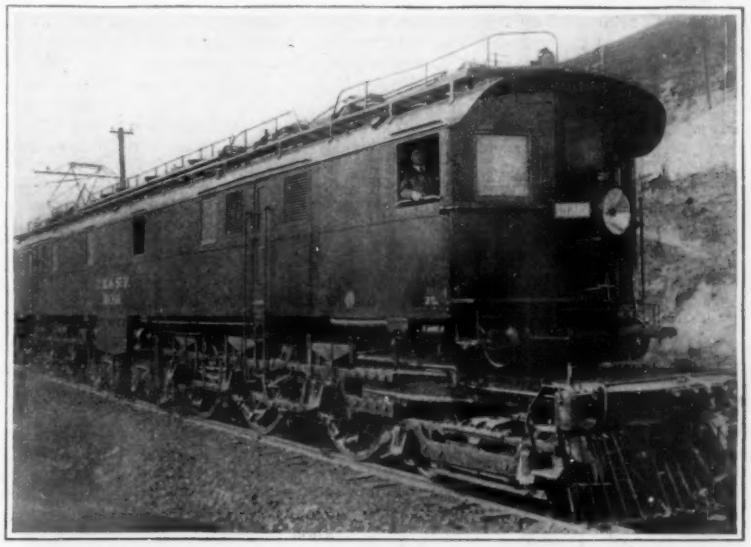
The present holder of the power championship for passenger locomotives is a type being built by the Baldwin Locomotive Works and the Westinghouse Electric and Manufacturing Company, for the Chicago, Milwaukee and St. Paul Railroad.

As most railroad men are aware, this railroad has recently extended its electrification, and in addition to the famous division over the Continental Divide, it is now using electricity to handle traffic over the Cascade Mountains, from a point near Seattle to Othello, Washington. This extension has necessitated additional electrical equipment of which the new locomotives form a part. Ten are being constructed altogether, and one was recently delivered to the railroad and at present writing is being tried out.

The most striking feature of this new type of locomotive is its great length. It consists of two duplicate Pacific type running gears, placed back to back and covered by a single cab, the over-all length being just under ninety feet. It is therefore, undoubtedly the longest, and in many respects the most remarkable looking thing on wheels. One would think that so long an affair would have trouble in going around sharp curves, but each of its several trucks is independent and takes care of itself so that there is no difficulty in this respect. In fact, those who have ridden on this locomotive, especially commend its easy riding qualities and have nicknamed it the "Pullman locomotive."

There are twelve drivers altogether, each 68 inches in diameter, driven through gears by six electric motors. These motors can develop a total of 4,200 horse-power for one hour and a normal starting drawbar pull of 100,000 pounds, though this pull can be increased up to the point of wheel slippage without injury to the electrical apparatus. The total weight of the locomotive is 275 tons, and weight on drivers 336,000 pounds.

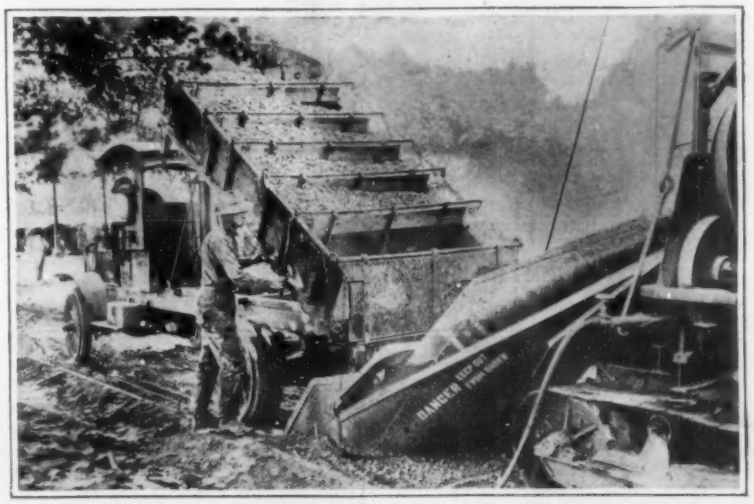
The speed of the locomotive, when hauling a heavy all steel Pullman train, is 56 miles an hour on level tracks and 20 miles an hour up the steep grades. On the down grades, regenerative braking is used in which the engineer controls the speed by merely changing electrical connections, without the use of air except to make full stops. A control station for the engineer is located at each end of the cab, with an aisle connecting the two. This particular type of locomotive will be used on the original Continental Divide section and the present locomotives will be re-geared for freight service. A different type is being constructed for use on the Cascade Section where the curves, grades and loads are such as to impose different requirements.



This 275-ton electric locomotive hauls through trains over the Great Divide

Starting from Cold on Alcohol

THE problem of starting internal combustion engines from cold on alcohol has been solved by Ralph McKay in experimental work for the Australian Institute of Science and Industry. The compression was reduced by controlling the admission of air and it was found that the engine fired regularly with pressures of from 35 down to 25 pounds per square inch. With a leather disk, punctured to allow enough air to be drawn to provide the correct mixture, placed over the air intake on the carburetor a 25 horse-power car was started without difficulty on methylated spirit. Another engine was started from cold without fail on the first attempt on 70 consecutive mornings.



The truck body that delivers to the concrete mixer just the amount of material required for one charge

Photo Enlargements by Expansion of Negative Emulsion

By A. H. Beardsley

WHEN the average amateur photographer obtains an unusually good picture he likes to have an enlargement of it. He may do the enlarging himself or he may take the negative to a photo-finisher. If he does the work himself, he may use one of the convenient daylight-enlargers or he may employ one of the many excellent electric enlarging outfits. In either case, the process is simple and the directions so explicit that there is little likelihood of failure. A recent unusual experience of an amateur photographer brought to light a remarkable though unreliable method of enlarging which was in vogue many years ago and which is of interest and value today by way of contrast to our present methods.

In the January issue of *Photo-Era Magazine* there appeared an article, "A Photographic Gambol" by L. B. Flint, an amateur protographer. This article has aroused considerable interest because of the unusual character of the phenomena mentioned. The one which led to the writing of this article I will let Mr. Flint describe in his own words: "As the subject selected offered considerable range in the gradations in the greens, it was decided to make two exposures, one with and the other without a ray-filter; in each case employing double-coated orthochromatic plates. After developing and fixing, the first surprise came, when, after the plates had been allowed to soak in the washing-sink for about an hour, it was found that the upper film of one of them had separated from the lower one and was curled up in another corner by itself. Further investigation disclosed a faint image remaining on the lower film which still adhered to the plate. Efforts to develop this image by intensification and sepia-toaching were unavailing. On examination, the top film was found to be in good condition, whereupon an old plate, size 12 x 16.5 cm., was stripped, the film carefully floated upon it and allowed to dry horizontally. When dry, it had firmly attached itself to the plate, but altered its dimensions—having stretched from 6.5 x 9 cm. to 8.2 x 11.4 cm.—without any appreciable evidence of distortion. *Thus we have at hand a method of enlarging not advocated in books.*"

Mr. Flint's interesting experience led me to investigate this matter of obtaining an enlargement by the removal or stripping of the emulsion from the plate. Apparently, Mr. Flint was under the impression that he had unearthed something new; and others more experienced than he, were of the same

(Continued on page 256)

The Mathematical Motor Truck

AN ingenious scheme for facilitating the mixing of concrete is seen in the motor truck illustrated herewith, which has its body divided into compartments, each of a capacity exactly accommodated to the charge of stone, or sand, or mixed stone and sand, which the mixer requires for a single filling. In operation the truck is run under the bin and the material run into it by a chute—and of course, no measuring of any sort is necessary, the compartments of the truck automatically attending to that, regulating the whole load and dividing it into exact fractions by the mere process of being filled. Then the truck is run to the mixer on the job, backed up to it, and hoisted into dumping position. The rear compartment is emptied into the mixer by releasing the tailboard; and when the charge has been manufactured into concrete, the next one is delivered by dropping the partition between the rearmost two compartments, just as the tailboard was dropped. In this way the process continues until the entire load of the truck has been delivered and converted into concrete; and all hand dumping and measuring is eliminated.

The Romance of Invention—IX

Pupin, Exponent of Pure Science

By C. H. Claudy

IN telling us his impressions of Dr. Baekeland, Mr. Claudy pointed out that here was a man who was scientist first, inventor afterwards. The same remark would apply to Professor Pupin, but with a difference. Dr. Baekeland's interest in science is a practical one—his entire mental tendency forces him to work in the field of chemistry, because that is the science that is closely and immediately applied today. But Pupin is like the mathematician who protested indignantly, when asked what were the applications of his latest work, that he didn't work in mathematics for the sake of applications, that he didn't know and didn't care what applications might be found—and who then added that he was sure some applications would turn up, for he had noted that these persistent physicists very soon found a way to apply any new discovery of the mathematicians, no matter how far removed from utility it might appear to lie. And this is the spirit of Pupin. He works in science without regard for the utility of his discoveries, simply for the love of making them. That so many of the things unearthed in this manner turn out to be eminently patentable and practicable and profitable is mute testimony to the Romance of Invention.—THE EDITOR.

MORE than one enthusiastic patriot, writing on "America, the Land of Opportunity," has chosen to illustrate his contentions with a reference to Professor Pupin, of Columbia University, citing the undoubted facts that an ignorant immigrant of fifteen, coming from Serbia to the United States in 1874, became a member of the faculty of a great University in fifteen years and during his subsequent life in that institution, so wrought in science as to achieve both academic fame and great renown in the world of science.

This is all very true . . . Michael Idvorsky Pupin, who graduated from Columbia University in 1883, was an ignorant immigrant boy entering this country in 1874. But without in any way detracting from the stimulus of America as a "land of opportunity" it must nevertheless be stated that too few immigrant boys became distinguished men of science to allow America all the credit. If the young Pupin had not had an inexhaustible thirst for knowledge, and determination and grit to carry him over and through a great many rough places in the road of learning, he would never have arrived at his destination at all, still less in so short a time.

Professor Pupin has also been introduced to readers of some periodicals as a wrestler and an athlete. Just why the combination of scholastic attainment and bodily perfection should so appeal to the average reporter, the present scribe has not the wit to say. Professor Pupin, is a heavily built, powerful, muscular man, and it is pleasant to recall that lovers of the Greek ideal in undergraduate life took young Pupin to their hearts only after he had demonstrated that he could wrestle and throw a champion athlete as well as a champion problem in mathematics. But he might be a bodily weakling and still be no less remarkable an exponent of what pure science can accomplish for a practical world.

For Professor Pupin is distinctly a scientist, as opposed to an inventor, an engineer, a manufacturer. His interest is in knowledge for the sake of knowledge, in the pursuit of investigations for the love of unravelling complex problems. He makes no pretense of despising money or underestimating the good wrought by such inventions and discoveries as make the life of mankind easier, happier or better. But he does not attack a problem because it is being pressed for a solution by commercial or economic interests; it must be to him "a worth while problem in science" before it engages his interest.

But with a full realization that the solution of many scientific problems have no immediate commercial application, Dr. Pupin believes that no knowledge which man can acquire is without some commercial value to some one, sometimes. "There is no worth while, purely scientific problem, the correct solution of which will not some day have a practical value," he told the present scribe, and then illustrated his point with an interesting account of some of his own work.

The name Pupin is known in every laboratory in the world which devotes itself to the solution of electrical problems. His contributions to pure physics, especially in the field of electricity are, many of them, foundations on which others build. Among these is the theory of selective tuning for the separation of mixed electrical oscillations. This theory was developed and completed by Professor Pupin in 1894, *two years before Marconi startled the world with wireless.* This theory, in the form of a patent, was sold to the Marconi company and by it used as the basis for selective tuning by which messages of different wave lengths could be received. Long before the wonder-working vacuum-tube rectifier was brought out, Professor Pupin had developed the principle and apparatus for rectification of alternating electrical forces, which was succeeded later by the early crystal and vacuum-tube rectifiers of the radiotelegraph.

But the most spectacular instance which Professor Pupin quotes, of the solution of a purely scientific problem proving of immense practical value, is in connection with what he himself regards as his most important contribution to both abstract and applied science. This is the formulation and demonstration of the theory of the propagation of electrical impulses over non-uniform electrical conductors. This is a fair mouthful of a title for a piece of work and without further explanation would have little meaning for the casual reader.

Michael Idvorsky Pupin, Scientist and Inventor

But let the casual reader consider for a moment, the telephone. The first telephones were between house and house. Then they began to be between city and city. And the further away the cities were the worse the telephone communication was. Many can remember the first "long distance" lines, when "long distance" and a hundred or so miles were synonymous terms. The buzzing, whirring, clicking, singing noises on the wire may have come from the "long distance" end of the 'phone but they were untranslatable into English. Telephone engineers attacked the problem from the 'phone end; better 'phones, better transmitters, better receivers, more sensitive instruments, was their idea. Professor Pupin, who had finished the work on his theory as a purely scientific problem, had little thought of its practical value until a friend, hearing this theory in a paper read before a scientific society, so urged and insisted that Professor Pupin obtain protection by patenting the idea, that he did so. Somewhat to his surprise and probably much to his disgust, he found that a telephone engineer, who had either heard or read the paper had already applied for a patent covering the same idea. However, Professor Pupin easily proved priority of invention and disclosure, and the "Pupin coil" as applied to telephony immediately came into use, extending telephonic communication from half a day's automobile run to a twenty-four-hour railroad journey.

The originator of the Pupin coil by no means quotes only his own work as instance of discovery in pure science being inevitably useful to some one, some day, in a practical, commercial way. He speaks of Langley, a scientist for whom he had a great regard. Langley was laughed to death, dying of a broken heart when press and government alike ridiculed his experiments in mechanical flight. Congress refused the great scientist a second appropriation of fifty thousand dollars, after the failure of his first man-sized "aerdrome"; another Congress appropriated almost a billion dollars for the building of planes—airplanes, the deciding factor in the great war. Airplane builders today depend much upon Langley's fundamental investigations into aerodynamics and his "pure science" is made practical and commercially valuable in every plane that flies.

"Is it possible that Einstein's theory of relativity may have a commercial value?" the writer wondered aloud, after hearing this.

"There is no reason why not, simply because we do not see it now," responded Professor Pupin. "By the way, it is arrant nonsense to say that only twelve men in the world have mathematics enough to understand Einstein's theory. There are plenty of scientists who understand it thoroughly. It appears now as if its greatest value was to come from the undoubted fact that it gives us our first glimpse of a possible clue to the understanding of the real nature of gravitation and the possible corroboration it affords for the theory that all matter is electrical in nature. Remember that the theory of gravitation is but two hundred years old—long for a man's life, short in terms of science. Yet here we are, two centuries after Newton, just getting a first small sight of a possible explanation of what it is. That exactly bears out my contention that all pure science may be useful some day; that no problem, no matter how abstract now, but may be of practical value tomorrow. People ask me if there is any prospect of solving the problem of unlocking the power in

(*Continued on page 256*)

Correspondence

The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.

The Helicopter

To the Editor of the SCIENTIFIC AMERICAN:

I have been much interested in an article in a recent number of your magazine relative to experiments conducted in propeller blades designed to lift an airplane directly from the ground.

My interest is all the greater because as the result of certain experiments I had been carrying on for some time at my home here, the Advisory Board wrote me two years ago asking me that I furnish them with such information as I might have in the hope that it might assist them in experiments they were then conducting. I of course sent on the result of my experiments.

Your article describes a radical departure in a machine that lifts itself into the air, developing 20.2 pounds to the horse-power. About two years ago you published an article regarding the scientific construction of airplane propellers, stating that the pitch increased as it approached the hub.

I have been experimenting for six years on propeller wheels. I mounted a shaft carrying a hub in bearings with ½ inch lateral motion. When the wheel started up the shaft moved endwise. On the end I attached a weighing device. This showed the thrust of the propeller. In this hub I mounted blades 1 inch long by 1½ inches wide, adjusting these to get the most thrust for pitch, adding on to these 1 inch at a time until I had a wheel 26 inches in diameter. I found that the pitch stood the same. Then putting two metal blades on this hub, each 12 inches long and 1½ inches wide, blades with flat driving face, this wheel developed 6 pounds lifting force with ½ horse-power. By taking these blades on a mandrill and curving the driving face to correspond with the under side of the airplane wing, they lifted 10 pounds, running 2,300 revolutions per minute.

I took this blade and twisted it so that it had more pitch at the hub. The least variation from the true pitch decreased the thrust. I told the Board that I had a kite with planes mounted on a bar like a monoplane, with the planes loose, so they would turn all around, but balanced so that when they caught the air they would come into the proper position and stay there. In all of my experiments I could always get one-third more out of a metal wheel than from a wooden wheel.

I sent the Advisory Board a model made out of tin, showing the shape of the blade, also showing them how to construct out of thin sheets of steel the edges, electrically welded. They replied that they had experimented with electric welding and had been unable to make it stand.

I am not in financial shape to go on and build a large machine and my experiments have been discontinued. But I have yet to be convinced that a machine cannot be built to lift itself from the ground.

S. N. MALTERNER.

Canton, N. Y.

Visible Sound Waves

To the Editor of the SCIENTIFIC AMERICAN:

In the December 6th issue of the SCIENTIFIC AMERICAN, under the heading of "Are Sound Waves Ever Visible," you abstract briefly an artice appearing in the May, 1919, number of *L'Astronomic*. In this article a French officer states that during the firing of heavy guns, which were at a conisderable distance, but between him and the sun, he observed that at the instant of firing, circular shadows advanced from the guns with great rapidity. The shadows apparently had their center at the guns; the sound was audible at the same instant that the shadow reached him. The question is raised in the article whether or not these shadows are cast by the sound wave of the gun discharge. I believe that undoubtedly this is the case.

As your readers may not all be familiar with recent studies in the photography of sound waves, it occurred to me that a brief reference to these researches might be interesting, particularly in connection with the above-mentioned article.

As is well known, a single sound wave causes a condensation of the air followed by a rarefaction. If the sound is intense, this change in the density of the air is sufficient, under certain conditions, to cause a distinct shadow of the advancing wave-front to be thrown on a plate exposed to some source of light and on the opposite side of the sound wave.

This fact has been utilized by a number of investigators and instantaneous photographs of such sound-wave shadows have been made. No one, however, has perfected this method of photography to as great an extent as the late Professor Wallace C. Sabine of Harvard. Professor Sabine's apparatus is the result of several years of patient and skillful development and has resulted in an equipment which enables the operator to obtain the photograph of a sound wave with great ease. It is possible, by his method, to produce a sequence of pictures showing the propagation of a wave through a cross section model of any desired shape. These studies have been particularly in connection with architectural acoustics. The sound-wave photograph method makes it possible to investigate the propagation of sound waves through models of existing or proposed auditoriums. This, in connection with other methods developed by Professor Sabine, makes possible the design, on a scientific basis, of auditoriums which will be free from many acoustical defects which have limited the efficiency of otherwise fine theaters and music halls. In the proceedings of the Franklin Institute of the State of Pennsylvania, January, 1915, is printed a lecture delivered by Professor Sabine in which he considers the application of these wave photographs to the improvement of the auditorium acoustics. A number of excellent photographs are reproduced.

As may be known to a large number of your readers, a similar method has been applied to the photography of rifle bullets in flight. Very interesting pictures have been taken showing the condensations and rarefactions of the air around the bullet.

In Professor Sabine's apparatus, the source of sound is a minute spark-gap across which a condenser discharges, producing an intense sound wave, but of very short length—approximately 1/20 inch. By a most ingenious device, a second spark is produced at an extremely short interval after the first spark. This second spark illuminates, for an instant, the sound wave which is advancing through the miniature model at the rate of approximately 1,100 feet per second, casting its shadow on a photographic plate situated at a proper distance from the model. No lenses are used. Of course, if a ground glass is substituted for the photographic pate, the shadow may be viewed directly provided the sound wave is sufficiently intense.

In view of the above facts it is quite conceivable that the great intensity of gun discharges may, under proper conditions, be sufficient to cause shadows visible to the eye, even though these shadows are moving at the rate of sound propagation in free air—namely, approximately 1,100 feet per second.

WM. H. CAPEN.

New York.

Who Can Answer This?

To the Editor of the SCIENTIFIC AMERICAN:

I note that you give space to Dr. Goddard's moon-rocket, and at the same time the daily press has more or less discussion of Signor Marconi's notion that Mars may be trying to signal to us. In connection with this matter of interplanetary communication, I wonder whether anybody has ever seriously worked out a suggestion as to how it would be done? I do not mean the technical means of signalling, but rather what I might call the vehicle for the communication—the message itself? Supposing that we have decided to signal to—well, Mars is as good as any; suppose we have decided to signal to Mars, and have found a way to make our signals carry to Mars, and have decided what we want to say to Mars. What then?

Shall we signal in English, or in French, or in what language? Perhaps the advocates of Esperanto would have us believe that it is such a simple and logical universal language that the Martians must already have developed it and put it in use. Or perhaps the enthusiastic mathematicians who tell us, with delightful generality, that mathematics is the universal truth and that therefore the first messages will be such as to convey some fundamental mathematical idea, will deign to work out their scheme for us, and tell us with just what mathematical truth we are to startle the Martians? and in what manner and in what way this will help one whit toward the establishment of an inter-planetary vocabulary? Has anybody a suggestion on this point?

New York. W. L. B.

The Kerosene Range

To the Editor of the SCIENTIFIC AMERICAN:

In your issue of January 3, I note an illustration and write-up covering a gasoline burning attachment for ranges, page 16.

For the past two years I have been using one of these attachments in my range, but instead of gasoline as a fuel I have been using kerosene, which is much cheaper, and nowhere near as dangerous. The kerosene burns in a gaseous state, and gives forth a blue flame, perfectly free from carbon, odor, or smoke.

I have read the SCIENTIFIC AMERICAN for the past twenty years and appreciate its worth-while suggestions, illustrations, and editorials more and more as the years go by. J. C. TEAL.

Rhinelander, Wis.

The Nature of Things

To the Editor of the SCIENTIFIC AMERICAN:

The editorial in your issue of December 20th under the above head calls to mind two errors of popular conception, viz.: suction and attraction.

Long ago it was demonstrated that what appeared to be a negative force called suction, was nothing more than a reduction in pressure at some point in a field of uniform pressure and that the amount of reduction was limited to the pressure in the field; the most usual field being our atmosphere with its pressure of about 14½ pounds per square inch.

If an imperceptible force causes two bodies to approach each other, how can we conclude that the bodies are "pulled" toward each other rather than "pushed" toward each other? We have a mechanical conception of how a "push" can be communicated from one body to another—by contact or impact—but have we a rational notion of how a "pull" might be communicated? In mathematics, the magnitude, direction, and point of application of a force determine the result, and it would make no difference whether the force were a "pull" or a "push," but it does make a difference in our conception of many things if we can conclude that all forces that we deal with are forces of repulsion, and that no force of attraction exists. For example: If two bodies are in a uniform dynamic field and they resist the dynamic action of the field, then they would eclipse each other in the direction joining their centers and in this direction the dynamic force between the two bodies would be less than that of the field by an amount depending upon the resistance of the bodies; so that the bodies would appear to attract each other though they are, in fact, "pushed" toward each other. The permanent magnet may have no magnetic properties, but only a peculiar physical condition that causes it to resist the action of a magnetic field in a different manner from most other bodies.

We may have an universal atmosphere with a pressure exceeding the tensile strength of our strongest materials that causes their particles to adhere; yet not to be able to measure the intensity, or variation, of this force because all of the materials we have to use are porous to this atmosphere. Surely something transmits the motion of light.

How can we explain the meaning of positive and negative ions, if all the forces we have are repulsive, as seems most rational? L. F. BREWSTER.

Philadelphia.

The Harmony of Hypotheses

To the Editor of the SCIENTIFIC AMERICAN:

Yours on "The Nature of Things" leads me to ask: Are we not soon to regard some seemingly incompatible theories as harmonious? Several have viewed the same fact, from different angles. Possibly our moon's history will then be given somewhat as follows: The parent nebula of the solar system was formed in accord with Lockyer's view. This having undergone various transformations in agreement with Laplace's theories, became our sun. At the time in the sun's history considered by Professors Chamberlin and Moulton it ejected a jet of matter. This was separated with segments by lanes (located as shown in my theory of celestial lanes and fences). The segments have become planets, the planets and their multiple satellite systems are largely located relatively as they are by reason of "fences."

The moon, after having been a planetoid, was captured by the earth as proved by Dr. Lee. Later its distance from us has been changed by tidal friction as shown by G. H. Darwin. T. M. BLAKESLEE.

Ames, Iowa.

Commercializing the Coyote

How a Beast That Was Not Worth Powder to Shoot Him Has Become a Valuable Source of Revenue

By John L. Von Blon

THAT despised howling pariah of the animal kingdom, the coyote, is today worth 75 per cent of the price of the sheep whose most dread enemy he long has been on the great western ranges. Three years ago his value actually was higher but wool and mutton have advanced disproportionately. A decade since he was rated at a little more than nothing. Now his warm, tough pelt is put to many uses and sells readily for $10 net to the trapper. When the war first became a digging-in proposition, and before America took hold, this hide sold for $8 and was exported to Europe to protect the shivering soldiers of the Allies in the wet trenches. At present the fur is employed in the making of fine sets for which that of various animals far beyond the reach even of the fat purse formerly was used, and it serves the purpose so well that purchaser and wearer appreciate no difference. First the coarse guard-hair is removed and thereafter the process of substitution becomes easy.

A pair of Mount Whitney coyote trappers, and one of their hauls

Less than four years ago I predicted in a national article that the price of good average coyote pelts would go to $10 each. Letters of ridicule and rude question regarding my mental status reached me from all parts of the country. Now that figure has been attained and the tendency still is upward, though unlikely to reach much higher. But more steel traps yawn for this beast than ever before. Thousands upon thousands are being taken and it may prove to be a long step toward extermination, which stockmen and ranchers would welcome. They lose heavily through his depredations. He is the original bolshevik—and good only "after treatment."

It is a strange fact that though generally known as a hungry, skulking roamer only of the plains and lesser ranges, the finest specimens of the coyote, and many hundreds of them, are found on the upper reaches of Mt. Whitney, in California, the highest American peak outside of Alaska. From there he preys at times on the 100,000 sheep of the rich Owens Valley on the one hand and the immense flocks of the great San Joaquin on the other. And there he is most relentlessly hunted for profit. Two Bishop (California) trappers, Thomas W. Key and his son, Walter, who gathered in more than 2,000 merely as a "side line" during the past six years, are now specializing and making heavy hauls; and so are a number of other professional hunters. Most of the traps are set at the edges of the forests and at elevations up to 12,000 and 13,000 feet, where only the weird baying of the big "wild dogs" and the roaring of the winds disturb the night silence.

These large mountain coyotes closely resemble timber wolves and some experts maintain that they are such while others pronounce them entirely unrelated; so there is a clash of authorities in the premises. Evidently they are true coyotes but a superior product of evolution due to peculiar conditions. Lured farther and farther up the grand slopes by the abundance of food, they gradually have developed a more formidable type—more hardy, swift, powerful and fierce than that of the lowlands. They bear splendid fur and are at home even on the tip-top of the loftiest summit, 14,501 feet. This is literally the "roof of the United States." From below it looks like a sharp point stuck up into the clouds but in reality it is a boulder-strewn flat more than four acres in extent. In winter it is unapproachable and inhospitable as death itself and the fur garnerer must get through and away early. The bones of one or two who failed lie in the snow beneath mighty precipices.

On Mt. Whitney and its white-crested neighbors of the stupendous Sierra Nevada, within sight of burning Death Valley and at the portals of semi-tropic southern California, trappers and sportsmen are gradually discovering that wild life teems in variety and numbers as in few if any other regions of similar proportions on the globe. The rarest and most valuable furs in the country, including some hitherto sought only in the Far North, come from there. The "belt" extends from Mt. Whitney a couple of hundred miles over to the border of the Yosemite, where the castellated Minarets bound the horizon with a row of spires 12,000 feet high and the mysterious Devil's Postpile rears its stone columns aloft; thence it passes off to the right and Lake Tahoe. Richest of its treasures for milady is the silver fox. Of these the Keys have captured half a dozen worth from $500 to $1,000 each, and many of smaller value. The silver fox's coat is coal black, with a luster of burnished white metal, and a white tip to the tail. Apparently it is quite abundant in the place referred to but extremely difficult to catch.

Red, gray, swift and cross foxes are numerous and vary in price from $3 to $50 or more, the former being most desirable. Foxes are seldom seen there below 7,000 feet and course up to 10,500. In this compass wood-mice, rats, chipmunks, squirrels, grouse, mountain quail and small birds by the million, with juniper and other berries, afford a tempting and unfailing food supply. This attracts also the bobcats, Reynard's worst enemies, which sometimes put their wary paws in the wrong place and succumb to iron jaws. Foxes are most successfully baited on a large scale by dragging part of the carcass of a freshly-killed horse through the brush and placing traps in the trail. Sometimes the bait is fastened on posts and the traps set about them. That is the method of the

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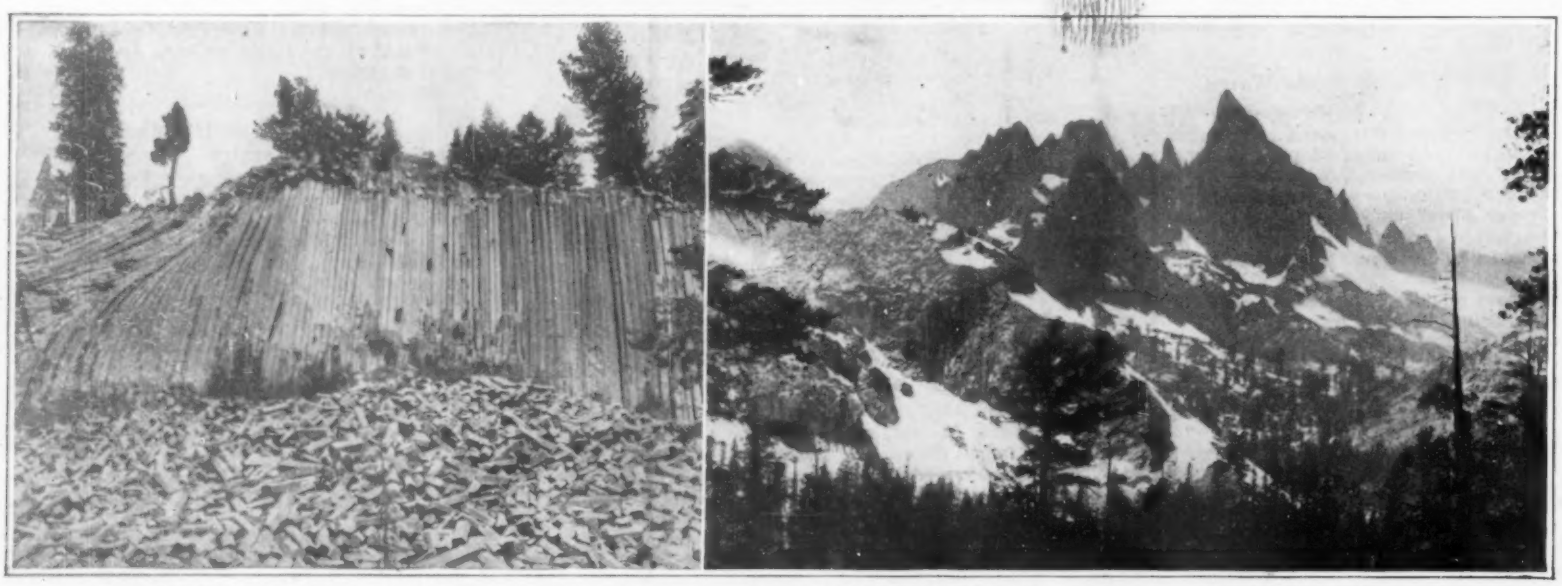
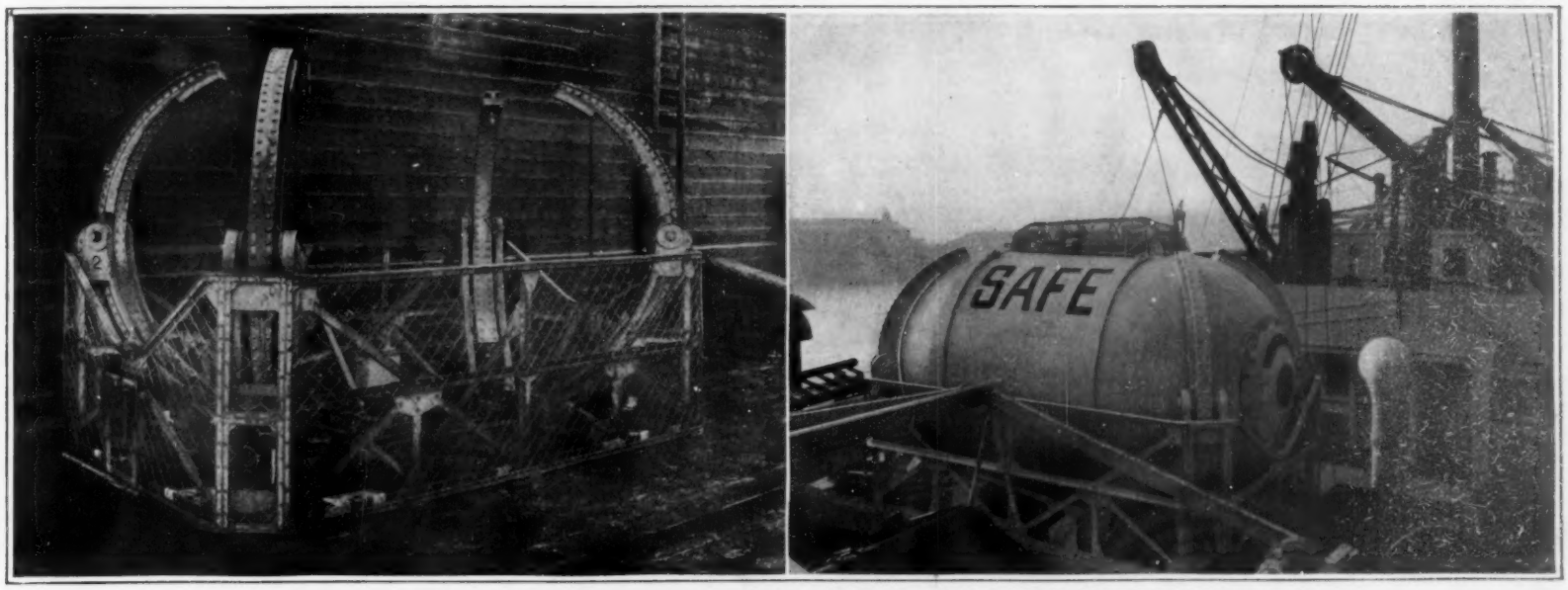
AMONG the curious effects of the war we find in numerous instances the destruction of well-established industries, and the revival of others that have been long dead. Less marked, perhaps, is the transfer of the seat of a given industry to a new region, or the breaking out of an old trade in a place where it has never been carried on or where it was long ago abandoned. Mr. Von Blon tells us here an interesting story of how the trapper is "coming back" in a part of California where commercial fur-bearing animals were for many years practically exterminated.—THE EDITOR.



Left: The Devil's Postpile, an extraordinary formation of basaltic columns, sixty feet and more in height. *Right:* A general view of the Minarets region

The Mount Whitney country in which the trapping industry is undergoing a revival



Left: The cradle in which the safe is carried on deck, showing how it opens to release the safe. *Right:* The safe in place in the cradle

How the wreck-proof safe now in use by the Netherlands Postal Service is carried aboard ship so that it can escape only when the ship sinks

Wreck-Proof Safe for Ocean-Going Mail

By James Anderson

THE Dutch Postal Service has recently put into use, on the mail steamers of the Netherlands Steamship Company, carrying the mails to and from the East Indies and other parts of the world, a very ingenious invention known as a floating safe, which as a protection of valuable mail during the perils of transit at sea is very likely to prove of most vital importance to commerce.

At the best shipwreck leads to the loss at sea of valuable mail containing drafts, checks, money orders, stocks, and bonds and thus results in serious delay in straightening out and settling affairs in relation to the same. The constant danger of such accidents has undoubtedly had a retarding influence on international commerce along certain lines, besides demanding high insurance rates and much duplication, as a matter of protection, of valuable papers before the originals were entrusted to the steamer mails.

Everything taken into consideration it is rather remarkable that no serious attempt to safeguard more thoroughly the mails in case of shipwreck has been made by the nations of the world long before this date. But the fact remains that the Dutch Postal Service is a pioneer in this very important direction.

The floating safe which the Netherland Postal Service is now using so successfully, is quite different in appearance from the ordinary safes with which we are familiar in banks, offices and stores. Instead of being square like the average safe it is oval in shape, painted a glistening white, and with the word "Safe" painted upon either side in big black letters, which stand out and can be seen at a considerable distance.

The outfit consists of a safe proper and a cradle to carry the same in. This cradle is really a framework of iron and stout wire netting. It will hold the safe under all circumstances, except when the

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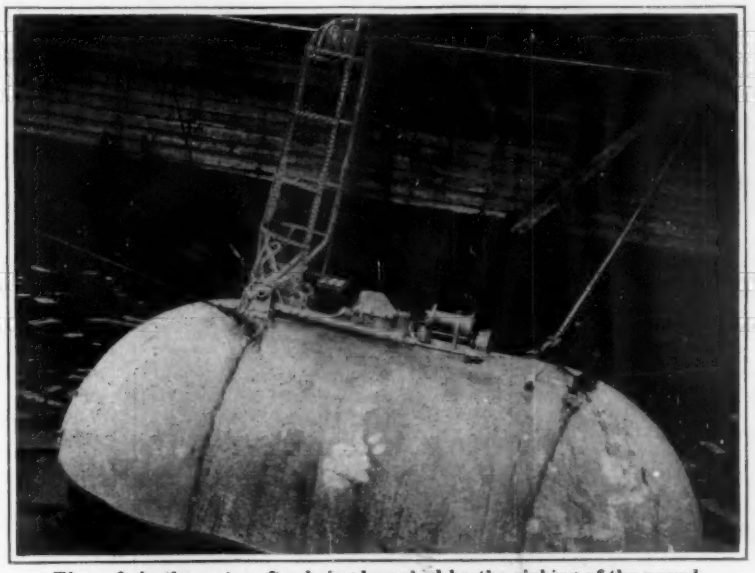

The safe in the water after being launched by the sinking of the vessel. Note the horn, the lighting apparatus, and the rocket stand

1. The pattern is outlined in copper strips, attached edgewise. 2. After the first firing the whole surface has become perfectly coated with the silver alloy. 3. The cells are filled with pigments in paste form with a small iron trowel.

Three phases in the making of a cloisonné enamelware

How the Chinese Make Their Beautiful Enamel-Work

By Sidney J. Hall

YOU have noticed, on an old plate, the network of cracks that appear in its surface. They are there because the glaze has cracked, and can be seen because the dirt has worked into the earthenware through the cracks. You also know that the colored pattern on some kinds of pottery wears off after a time, while that on other kinds, especially on some porcelain, will remain there forever. Why is this? Because it is burnt in, you say.

There is a kind of pottery and metal-work made in China and Japan, which, for permanency and beauty, surpasses anything we have ever been able to produce. It is commonly known as Chinese and Japanese enamel-work. The Chinese have known how to make it for about 2,000 years; we do not know how to do it today. Such consummate skill is required, and the ingredients of the pigments used have been so well guarded, that although we know the process we have been unable to duplicate the work.

The usual foundation for cloisonné-work, as it is called (from the French *cloison*—a cell), is a copper or bronze vessel—a vase or bowl, for instance. This is delivered, roughly polished, by the coppersmith.

A sketch is made, in color, by an artist, of the design to be worked on the vessel. The drawing must be accurate in both color and detail.

Now the artisan in enamel takes both drawing and copper vase. You can picture him, in his bright-colored flowing Chinese clothes, sitting cross-legged on a mat on the floor of his thin-walled workroom, or maybe squatting on the ground outside. Using the artist's drawing as a guide, as an engineer works to a blueprint, with a bamboo stylus he traces a fine outline of the design, in black, upon the surface of the vase.

The next step in the process of making cloisonné-work requires almost miraculous skill. Having traced the outline, the artisan

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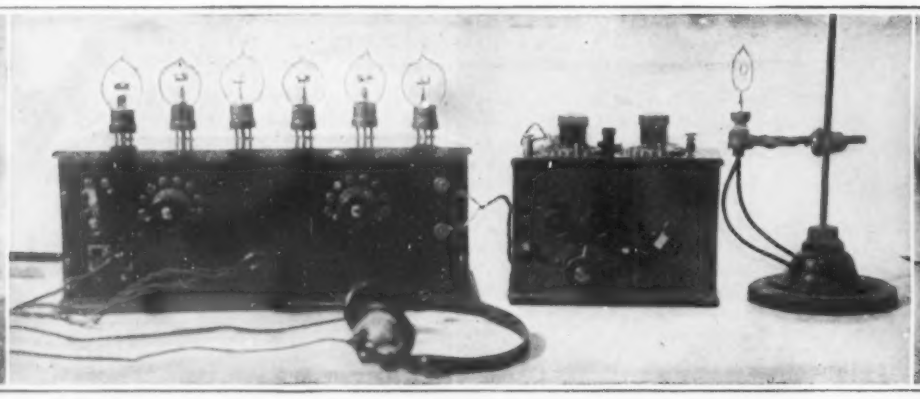
Thermopile mounted in sealed bulb, and parabolic mirror



Complete receiver for infra-red rays, consisting of six-stage amplifier, potentiometer and tikker unit, thermopile, and head 'phones

Diminutive horn which produces direct audible signals

Putting Infra-Red Rays to Work

How the French Army and Navy Make Use of Heat Rays for Invisible Signalling

By George Gaulois

A SMALL searchlight provided with a shutter mechanism for breaking up the beam of light into the dots and dashes of the Morse code; a special screen for that searchlight which permits only the invisible infra-red rays to pass on; a parabolic mirror several miles away which gathers the infra-red rays from the transmitting searchlight and concentrates them on a special heat-operated detector; a collection of vacuum-tube amplifiers, potentiometers, interrupters and other equipment—all these things blended together in the proper way make a most remarkable system of infra-red ray or invisible light signalling developed by the French during the world war.

Infra-red and ultra-violet rays are commonly termed invisible light, because they are invisible to the human eye although visible to some of the living creatures. Light rays beyond the extreme red of the spectrum are invisible to the human eye because their wave length is greater than those to which the nerves of the human eye are sensitive; or, to state the same thing in another way, because their frequency is too weak to be detected by our organs of vision. So the infra-red rays, with which we are very much concerned in the description that follows, are to all intents and purposes invisible and inaudible and hence cannot be detected by the usual means.

The principal physical action produced by infra-red rays is to heat those objects on which they fall. For that reason they are often referred to as heat rays. These rays can be reflected, refracted, absorbed, polarized and diffracted. And it is precisely these properties that have been taken advantage of in developing the French system of invisible signalling with infra-red rays, under the guidance of J. Herbert-Stevens and A. Larigaldie of the French Army.

Small portable infra-red transmitter and receiver combined, with three-stage amplifier

The new system of invisible signalling has several advantages over other existing means, just as it has several disadvantages. In truth, in military communication it fills a need that has remained untouched despite the heliograph, radio telegraph and telephone, field telegraph, semaphore, wig-wag, and so on. The infra-red telegraph system requires no connecting wires between the two stations, hence it is ready for instant operation despite its extreme portability; and it is immune to the danger of interruption due to military action. It is a wireless system, so to speak. Most important of all, this system insures absolute secrecy, which cannot be claimed for any other existing method. In military use the infra-red telegraph messages cannot be intercepted by the enemy except by the merest chance, since it is necessary first to locate the invisible beam of light, and then employ suitable apparatus to translate the rays into intelligible signals. And even if the enemy did intercept the beam, the fact immediately becomes known to the operators, and the beam can be shifted to a predetermined point so as to baffle the eavesdropper.

The transmitting end of this system consists of a source of light which is rich in infra-red radiation. A parabolic reflector concentrates both the visible and the invisible rays into a thin pencil of light which is projected in the direction of the receiving station. However, before permitting the light rays to leave the projector, they are passed through a special screen or ray filter which absorbs all the visible rays and passes only the infra-red or invisible rays. This screen consists of black manganese-dioxide glass or a colored gelatine or cellophane.

As for the actual generation of the infra-red rays, the electric arc is preferred to all other forms of illuminants because of its great volume of light. Messrs. Herbert-Stevens and Larigaldie have made numerous

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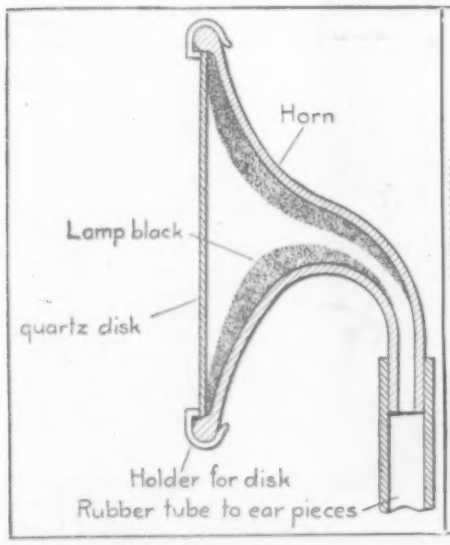
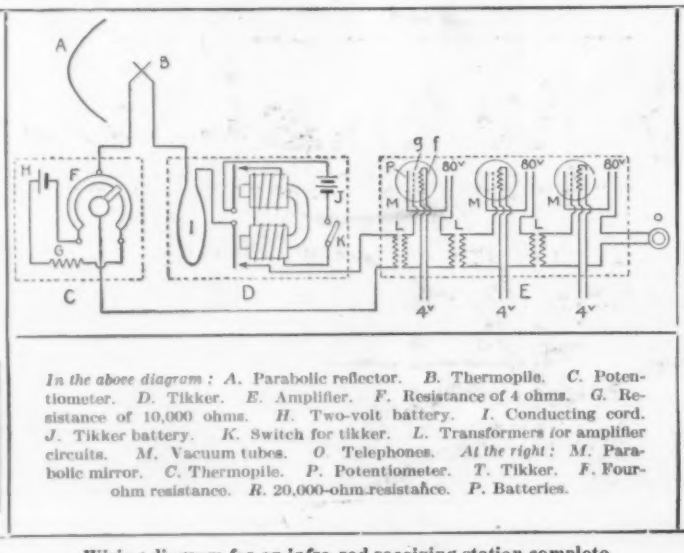
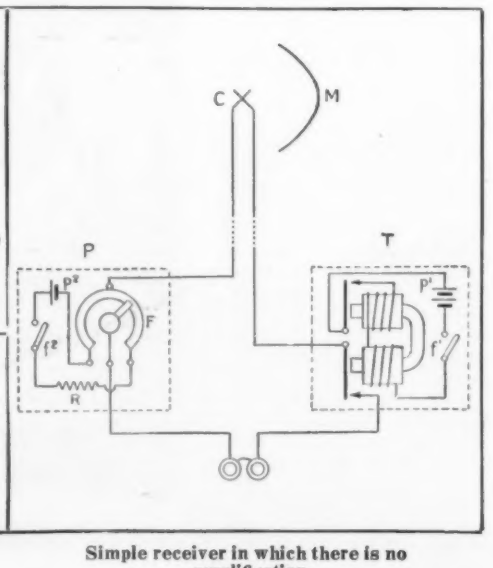


Cross-sectional view of the diminutive horn device



In the above diagram: *A.* Parabolic reflector. *B.* Thermopile. *C.* Potentiometer. *D.* Tikker. *E.* Amplifier. *F.* Resistance of 4 ohms. *G.* Resistance of 10,000 ohms. *H.* Two-volt battery. *I.* Conducting cord. *J.* Tikker battery. *K.* Switch for tikker. *L.* Transformers for amplifier circuits. *M.* Vacuum tubes. *O.* Telephones. *At the right:* *M.* Parabolic mirror. *C.* Thermopile. *P.* Potentiometer. *T.* Tikker. *F.* Four-ohm resistance. *R.* 20,000-ohm resistance. *P.* Batteries.

Wiring diagram for an infra-red receiving station complete with three-stage amplifier

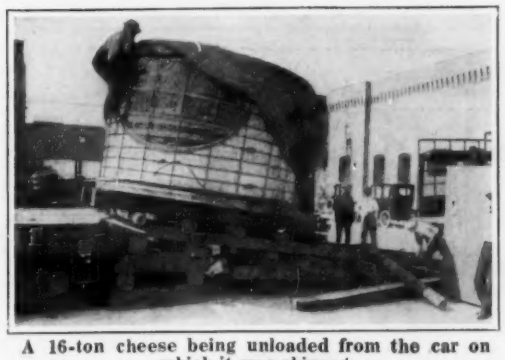


Simple receiver in which there is no amplification

The Biggest Cheese

THE picture that goes with this story looks as though it might be intended to represent the travels of a tiny gas-tank. As a matter of fact, however, instead of being a case of the smallest in the world, this cylindrical affair is the largest thing of its sort ever made—the largest cheese, in fact. It was made to exhibit in connection with a recent dairy show at Chicago. It is 8 feet tall, 10½ feet in diameter, and 33 feet around its circumference. It was manufactured in Appleton, Wis., and when packed for shipment to Chicago the entire bundle weighed 20 tons; the cheese itself comprised 16 tons of this total. The milk to make this huge cheese was gathered from 1,800 farms, and it is estimated that 12,000 cows contributed to it.

Its combined size and weight made the transfer of the cheese to and from the cars quite a problem. Our picture shows it being unloaded in Chicago, with the aid of nine huskies, a power-operated windlass, rollers, block and tackle, and a specially constructed inclined stage. Some statistical genius has figured that the cloth to wrap the big cheese cost $260; and worse yet, that at the rate of one cheese sandwich per day, the lucky purchaser of this dainty bit has enough cheese to last him till the year 4721.



A 16-ton cheese being unloaded from the car on which it was shipped

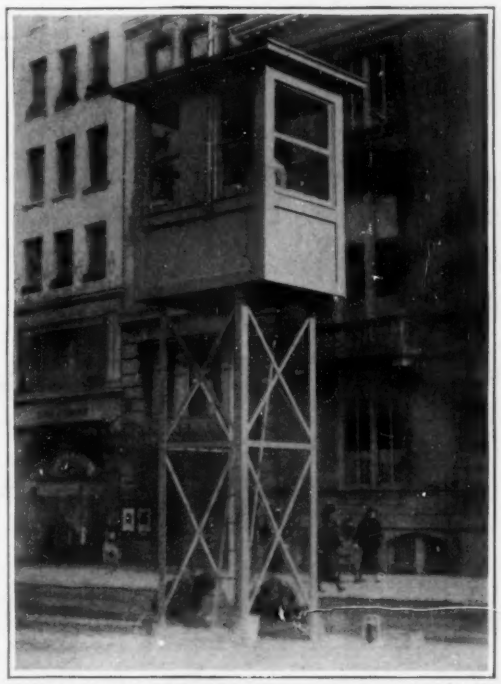
The Traffic Tower

VARIOUS schemes have been put forward in several of the more congested cities for safeguarding the traffic officer from the traffic which he is supposed to control. In the latest of these, now being tried out in New York, the additional advantage is secured of giving the cop a position from which he can get a much more comprehensive survey of the traffic streams bearing down upon his corner than has been possible.

Our photograph shows what the proposed traffic tower looks like. It is of much more ambitious character than the usual means proposed for raising the policeman above the general level of the street, as will be seen at a glance. In fact, it is frankly modeled after the railroad signal tower in more respects than one.

These towers are being tried out at two of New York's most desperately crowded corners—Fifth Avenue and 42nd Street, where the usual volume of traffic that will be found at the intersection of leading cross-town and up-and-down thoroughfares is vastly increased by the Fifth Avenue busses, by the proximity of the Grand Central Terminal, and by the fact that this district is at once one of hotels, of offices, and of great retail shops; and Fifth Avenue at 57th Street, the neck of the bottle for all the traffic that passes through Central Park, up and down town on Fifth Avenue, over the Queensboro Bridge, and anywhere in New York via the motor busses, nearly all of which pass this corner or, worse yet, turn there. While of course no such elaborate system is contemplated as that of the railroad signal tower, with its interlocking block signals and the numerous sidings which are ordinarily controlled from the nearest block tower, the general scheme is to be one of signal lamps, as in the case of the railroad.

The signal tower should solve all the problems of the traffic officer save one. The mere cutting off of traffic on one of two intersecting streets, to allow traffic to pass through the other, will be much more effectively cared for this way than by an officer who is half concealed amid a maze of vehicles. But the real problem of the traffic cop is the sorting out of the vehicles that want to go straight ahead from those that desire to make the turn. Those turning to the right create no problem, unless there are two or more parallel lanes of traffic in each direction and they try to turn out of one of the inner lanes and cut across the outer ones. But when it becomes necessary to take the long turn to the left on the intersecting street, the driver involved *must* cross the line of vehicles moving in the opposite direction along the street out of which he is turning. The officer on the pavement can hold up individual cars affected by this incident long enough to allow the turning car to thread its way through the maze; the officer in a high tower has not this advantage. Whether all the other excellent features of the tower will be sufficient to overcome this will appear after trial. An effort is to be made to overcome or at least to minimize the difficulties of the traffic signalman under this head by providing him with a third light in each directon, in addition to the two which would be employed for "Stop" and "Go." This third signal, presumably, will cut off the traffic along the two intersecting lines which must be crossed by the car making the long turn, while leaving open the lines out of which and into which he is turning. With proper coöperation on the part of the drivers, it would seem that this might work well; at any rate, it is decidedly worth a trial if there is any chance that it would make the traffic tower practicable.



The latest style in traffic towers, as now being tried in New York

Restoring Mexico's Railroads

SHORTLY after the beginning of the revolution against Huerta, in 1913, and for a long time subsequent thereto, the destruction of railroad tracks, bridges, stations, etc., became common practice in Mexico in order to hamper the movements of opposing forces. Some novel devices were employed in carrying out this destructive work, as set forth in these columns at that time. Tracks were destroyed and rebuilt over and over again, as the roads were captured and recaptured by different factions, and if destruction was rapid, so was restoration. The Mexican railroad men showed themselves experts at this sort of work, and it was a constant matter of surprise to the foreign correspondents with the Constitutionalist Army (of whom the writer was one), to see how quickly traffic was restored upon lines which had been so thoroughly ruined that nothing but some bent and twisted rails and the right-of-way were left.

The work of reconstruction proceeded as rapidly as the different portions of the country were pacified by the present authorities, and now every road in the Republic is in operation with the exception of a few unimportant branch lines, while new lines have been built in several localities, bridges reconstructed, stations erected, and all this from the net earnings of the roads themselves, without calling for a dollar of outside money.

The latest lines to be restored were in the State of Morelos, so long dominated by Zapata but entirely pacified during the past year by General Gonzales. The accompanying photographs illustrate the manner in which a good-sized bridge that had been blown up by the Zapatistas on the line from Puebla to Cuatla, was restored to its former position, repaired and put in good order for traffic, and all by the use of simple appliances. As will be seen the abutment upon or against which one of the spans rested was partially dynamited and the end of the structure dropped into the ravine beneath. It is a testimony to the good character of the masonry of this abutment that no more of it was injured than is shown. As will be noted, a gallows frame of heavy timber was erected on the abutment from which the span had been dislodged, and from this a steel cable was led to a pulley attached securely to the end of the fallen span. The cable led back to a derrick car anchored to the track at the opposite end of the bridge and passed over another pulley on the end of the derrick boom. From this it was taken to the pilot of a powerful engine and attached thereto. When everything was "all set," signals were given and the locomotive slowly and steadily raised the span to its original position on the face of the abutment. The men who planned and carried out this feat are justly proud of their accomplishment.—By *G. F. Weeks.*

Three phases of the engineering work of restoring a Mexican railroad bridge dynamited by rebels

THE GENIUS

SOMEWHERE in the United States Uncle Sam approves the gifts that his sons of genius create for the glory of his name.

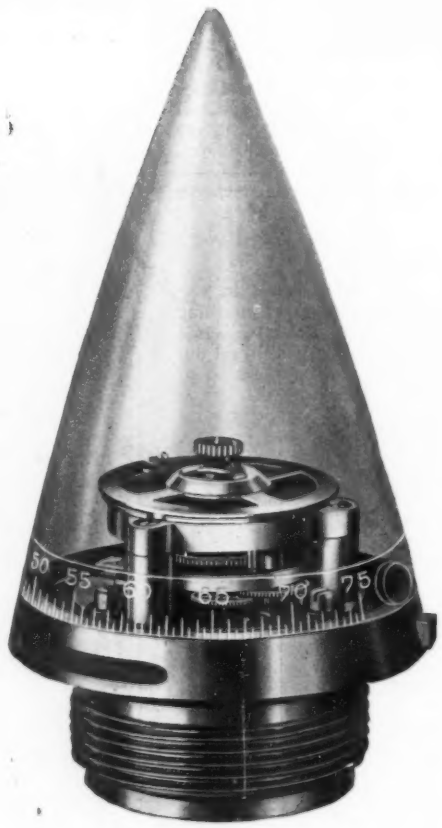
It is night. A few hooded and powerful electric lights search the darkness to reveal a huge gun, around which are gathered a few men who serve this giant of strength.

A sharp word of command! A flame of fire! A concussion that rocks the earth! The roar of a shell! A few tense, numbered seconds! Then, out there on the far horizon, a burst of fire miles away — an explosion timed to infinitesimal moments by Waltham.

This, the triumph of Waltham genius — a time-fuse that splits a second into a hundred parts — that far exceeds in instantaneous accuracy all other time-fuses hitherto invented — that sends each shell to its destination governed by Waltham's inventive genius hidden in the apex of the shell.

Imagine this device, light enough and of such delicate accuracy to explode the charge at a hundredth of a second, fired in a shell with a velocity of 2,700 feet per second and leaving the gun's rifled barrel at 25,000 revolutions per minute.

Talk of "position" time-keeping — here is a whirligig of motion — a "position" test that subdues competitive argument. And imagine a timepiece strong and durable enough to endure a blow, a strain, a stress of two pounds to each grain of its weight. A terrific reaction for the honor of America when the gun is fired.



Waltham Time-Fuse

Never in the world's history has there been such miraculous time-keeping, such performance, such absolute reliability under such abnormal conditions. As Americans, we have a right to be proud of Waltham genius.

WALTHAM

THE WORLD'S WATCH OVER TIME

OF WALTHAM

Waltham genius! What is it—but doing for nearly three-quarters of a century extraordinary things in an extraordinary way. If genius means taking infinite pains, then Waltham genius in this time-keeping invention has won its supreme tribute.

But if it had not been for nearly three-quarters of a century filled with work *behind* the Waltham time-fuse, it would not have been years *in front* of all others. Pre-eminence is its own reward.

Years of concentrated development on an infinitesimal unit—ofttimes out of sight in the works of the watch—have added renown to the name of Waltham.

The Waltham Watch, upon whose universal time-keeping the sun never sets, is but an older brother of this marvelous time-keeper in the shell.

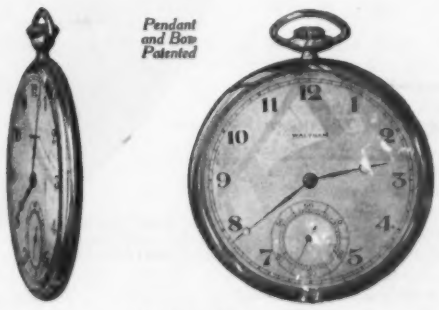
We have made many statements of Waltham invention in the mechanics of watchmaking—we have opened the door of the "works" in a Waltham Watch and created American pride in this Waltham masterpiece. We have claimed world leadership in watchmaking. "Here are the proofs" has been our challenge and our pride.

Proofs we have given and still more proofs we intend to give: science at its utmost in the alloy of a metal, in the polishing of a part, in the setting of a jewel, in the hardening and tempering of steel, in the design of a balance staff, in the bend of a guard pin or the structural curve of a spring—little things, hidden things.

Yet it is these scientific inventions, developments—call them what you will—that have carried the fame of Waltham unto the uttermost ends of the earth.

And we are about to write another illuminating chapter that will take you still closer to the heart of fine watchmaking, and give you still clearer reasons why the little things of Waltham genius add their quota of proof to Waltham dominance.

Read these advertisements, wherein we put the magnifying glass in your eye to see the hidden reasons why this truly American watch is justly called Waltham, "The World's Watch Over Time."



Waltham Colonial A
Extremely thin at no sacrifice of accuracy
Maximus movement 21 jewels
Riverside movement 19 jewels
$200 to $325 or more
depending upon the case

This story is continued in a beautiful booklet in which you will find a liberal watch education. Sent free upon request. Waltham Watch Company, Waltham, Mass.

WALTHAM

THE WORLD'S WATCH OVER TIME

The Heavens in March, 1920

Where the Light of the Sky Comes From, and How Much of It There Is

By Professor Henry Norris Russell, Ph.D.

WE ordinarily speak of the midnight sky as "dark"; and, indeed, at a first glance the stars appear to be set on an almost black ground. But the background of the sky is really far from dark. We realize this at once when we see clouds scattered over an otherwise clear sky, and even more when we are in the shade of trees, and catch glimpses of the sky between them. Such common experiences are enough to show that the whole expanse of the heavens is full of light which does not come from the individual stars that are visible to the unaided eye.

Where does this light come from? Much of it, at least, originates in the vast multitude of stars that are too faint to be seen without a telescope, but so numerous that their total light far exceeds that of the brighter ones which we can see separately. Where these faint stars are most thickly sown in the sky, it looks brightest; hence the Milky Way.

All this has been known for more than a century; but it is only in recent years that the attempt has been made to measure the brightness of the sky background even approximately. This was first done by Newcomb, nearly twenty years ago; and the surprising fact was brought out that the Milky Way averages only about twice as bright as the darker regions of the sky remote from it. Our impressions, based on appearances, without measurement, would lead us to a much higher estimate of the relative brightness of the Galaxy; but such impressions are notoriously untrustworthy. The fact is, the brightness of the non-galactic sky is so uniform that our eyes get used to it, and we notice only the increased brightness in the Milky Way.

A more serious difficulty is this: From actual star-counts, it is found that the brighter telescopic stars are three or four times as numerous in the Milky Way as in regions of the sky remote from it, and the fainter ones at least six or seven times as numerous per square degree. We should therefore expect the Milky Way to appear at least five times as bright as the sky near the galactic poles, instead of only twice as bright. What is wrong?

This difficulty was first solved by Yntema, a student of the distinguished Kapteyn, of Groningen, Holland, who from a long and careful series of measures concluded that most of the "sky-light" in regions far from the Milky Way does not come from the stars at all, but from a faint luminosity in the vicinity of the earth—perhaps resembling a faint, uniform, permanent Aurora. Another valuable contribution to this problem has just been published by a second Dutch astronomer, Van Rhijn, who made his observations at Mount Wilson, and has worked them up since his return to Groningen.

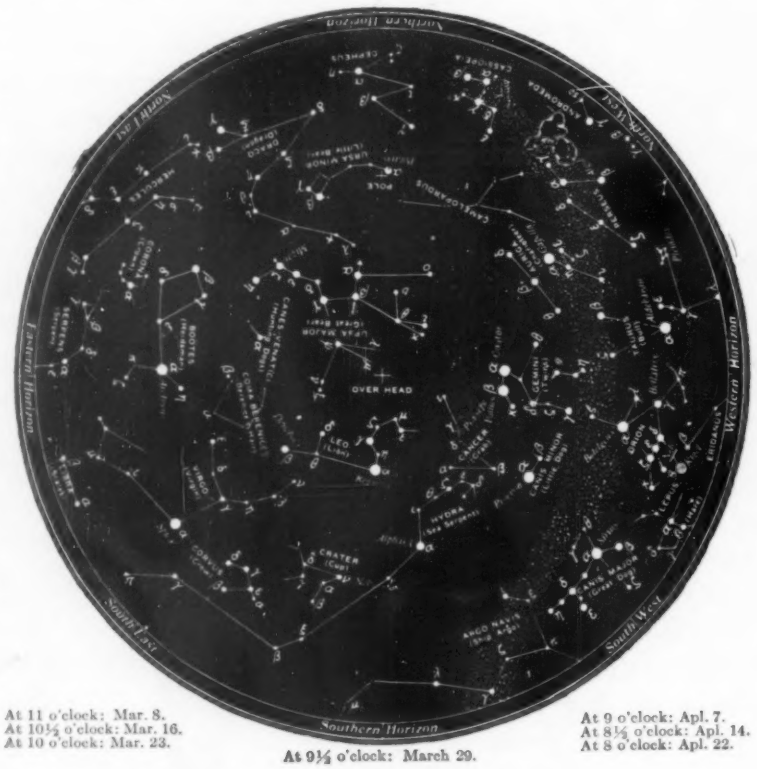
The troublesome problem of measuring the brightness of the sky was solved by means of a white, ring-shaped screen, which could be set up so as to be seen against any desired part of the sky. The side of this screen nearest the observer was illuminated faintly by a lamp in an adjustable position. If not thus illuminated, the screen would appear dark against the sky; if too strongly lighted, it would look bright. For some intermediate intensity of the illumination it would disappear altogether as a separate object, blending exactly in the sky behind it; and in this way a measure of the brightness of the sky, accurate within one per cent, could be obtained.

Measuring the Sky-light

The discussion of the measures was much simplified by the fact that we now know enough about the number and brightness of the stars in regions of the sky remote from the Galaxy to enable us to calculate the total light which they give. It is found that, on the average, the aggregate light from the stars in a square degree near the galactic pole is very nearly equal to that of one star of the sixth magnitude. We may take this amount of light as our unit in our future discussion.

Now the actual measures show that the observed brightness of the sky near the North Pole is not one unit on this scale, as it should be if the light came from telescopic stars, but about eight times as much. The excess must be what Yntema calls "earth-light," and must originate elsewhere than in the stars.

By an ingenious system of combination of his observations, Dr. Van Rhijn has shown that the brightness of this part of the sky-light depends upon the distance of the region under consideration from the sun, and hence that most of it is due to an extension of the zodiacal light over the whole sky. It is well known that the conspicuous luminosity in the sky along the ecliptic near the sun is due to the reflection of sunlight by fine dust or meteoric particles scattered through interplanetary space, and most numerous near the sun. Van Rhijn's work shows that this cloud of "cosmic dust" must extend well beyond the earth's orbit and that no part of the sky is free from this reflected light. According to his calculation, the intensity of this reflected sunlight, even near the poles of the ecliptic, is 4½ of our units, and much greater than the light of the stars themselves except in the Milky Way. Along the ecliptic the reflected light is about twice as strong, even remote from the sun, while at a distance of forty degrees from the sun it rises to more than thirty units of our scale, and much surpasses the Milky Way.



At 11 o'clock: Mar. 8.
At 10½ o'clock: Mar. 16.
At 10 o'clock: Mar. 23.

At 9 o'clock: Apl. 7.
At 8½ o'clock: Apl. 14.
At 8 o'clock: Apl. 22.

At 9½ o'clock: March 29.

NIGHT SKY: MARCH AND APRIL

After allowance is made for this zodiacal light, and for the light of the stars, it is found that there is still another source of light in the sky, which gives an illumination that is faintest overhead, but that increases gradually toward the horizon. This is interpreted as true "earth-light," arising from a permanent aurora in the upper atmosphere. It is known that most of the light of the aurora is produced in a layer only a few miles thick, and about sixty miles above the earth's surface. The more obliquely we look at this layer, the greater is the effective thickness and the brighter the auroral light (except as the absorption of light in the lower air cuts off the brightness near the horizon). The intensity of this auroral light varies irregularly from night to night. On the average, Dr. Van Rhijn finds that at the zenith it amounts to a little more than one of our units.

After allowing for the zodiacal light and the aurora, the amount of star-light can be found. It varies from one unit near the galactic poles to 4½ at a distance of twenty degrees from the central line of the Milky Way, and eight units on that central line itself. These are average values, and are doubtless considerably exceeded in the brightest of the great star-clouds, such as those in Sagittarius. Summarizing Van Rhijn's conclusions, it appears that only about half the light of the sky, even in the Milky Way, comes from the stars, and that in regions far from the Galaxy the stars contribute but a small fraction of the whole. Of the remainder, much the greater part is due to sunlight reflected by meteoric dust in interplanetary space, while perhaps one-fifth arises in the earth's atmosphere from a faint permanent aurora.

Sky-light from Three Sources

According to his calculation the total light of all the stars in the heavens amounts to that of 1,440 stars of the first magnitude. If distributed uniformly over the whole heavens, this would equal three and one-half stars of the sixth magnitude per square degree. The average brightness of the sky illumination due to the zodiacal light is a little more than twice as great, amounting to 7.2 such stars per square degree, or 2,980 first magnitude stars in all. The average brightness of the aurora amounts to 1.8 sixth magnitude stars per square degree or 750 first magnitude stars for the two hemispheres. The illumination of the ground on a clear starry night is of course derived from only the visible hemisphere, and is moreover weakened by the absorption of light in our atmosphere. Allowing for this, it appears that the whole light on such a night is equal to about 1,400 times the light of a first magnitude star, or about one two-hundredth the light of the full moon. Of this, one-seventh comes from the permanent aurora in the atmosphere, two-sevenths from the stars, and four-sevenths from sunlight reflected by the fine particles which are responsible for the zodiacal light.

Mention should also be made this month of several happenings. A faint and apparently stellar object, discovered by the Spanish astronomer, Comas Solà, late in January, and originally announced as a comet, turns out to be an asteroid with a period of about 4¼ years and moderate eccentricity and inclination. The list of new stars discovered by Miss Mackie on the Harvard photographs has been extended by one in Lyra, in 18h. 49m. 30s. R. A. + 29° 6′ declination, which rose from the 16th to the 6th magnitude between December 4th and 6th. A recent telegram from Mount Wilson reports its spectrum of the characteristic sort, with broad bright lines and dark lines enormously displaced toward the violet.

The same telegram reports the observation of bright hellum lines in the spectrum of the well-known variable star Omicron Ceti, along with remarkably widened and dispaced hydrogen lines. This discovery, along with the earlier Mount Wilson observation of bright nebular lines in the spectrum of the long-period variable R-Aquarii, indicates that the phenomena of these long known but little understood objects are very complex. We have as yet no idea of what is really happening in these stars, but the increased activity of observation which will doubtless follow these remarkable discoveries may help to solve the riddle.

The Heavens

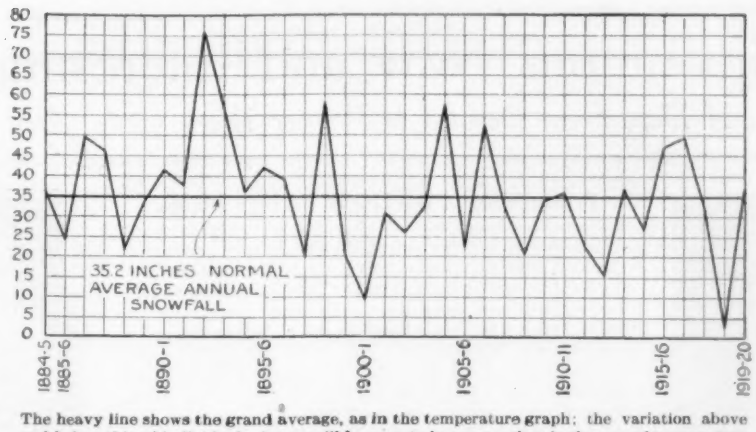
At the hour chosen for representation by means of our map, Leo is high on the meridian, carrying the brilliant planets Jupiter and Saturn. Below him is the long line of Hydra, and the smaller group of Crater and Corvus, with Virgo to the left. Mars, which is in the eastern part of the latter constellation, is well up in the southeast. Bootes is higher in the east, with Corona and Hercules below. Ursa Major is north of the zenith, Draco and Ursa Minor below, Cassiopeia and Cepheus on the northern horizon. Auriga and Perseus are in the northwest, Gemini

(Continued on page 261)

What About the Old-Fashioned Winter?

By J. Malcolm Bird

ON all sides the present winter has been hailed, with joy or sorrow, according to the individual viewpoint, as of the good old-fashioned variety, the kind we used to have back on the farm but have not seen since. There can be no escape from the conclusion that as regards concentrated unpleasantness, the winter season of 1919-20 is in the blue-ribbon class; but if we marshal the figures to see why this is so, we shall have to admit that it must be due to combination of circumstances rather than to any extreme severity in the measurable characteristics which we usually think of as belonging to winter. The present winter is not the coldest on record, nor the snowiest, nor the longest; it is possessed of no other single quality in superlative degree.

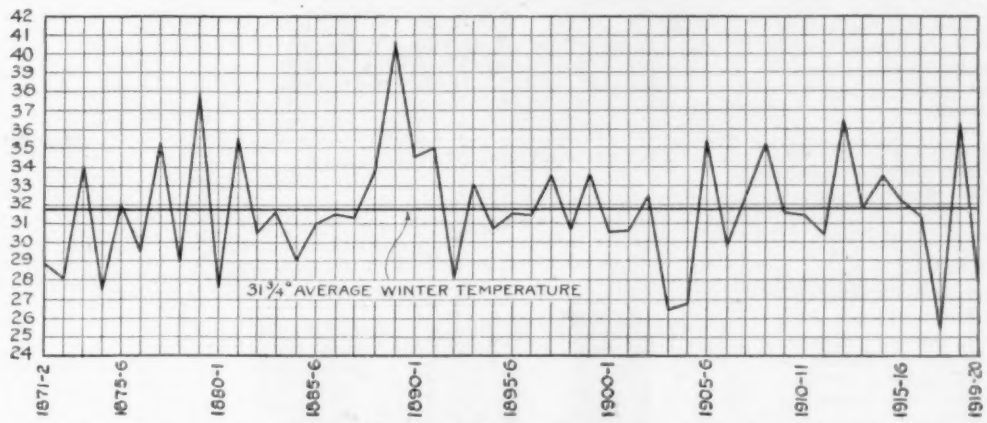


The heavy line shows the grand average, as in the temperature graph: the variation above and below this of individual winters will be seen to be greater than in the case of temperature

The snowfall for 36 years

The three charts on this page exhibit the variation and the average of winter weather for a good many years past in and around New York City. Not that New York winter is especially representative, but merely that the observations here go back over a good many years and are complete and reliable to a degree that leads us to prefer them over the records of any other section of the United States that is subject to winter weather.

The first characteristic of winter is that it is the season of cold weather; so we may look first at our temperature graph. The figure plotted here for each winter is the average temperature for the entire winter season, as determined by the calendar. The grand average of these averages is 31¾ degrees, which therefore stands as the mean winter temperature of New York over a period of fifty years. The variations shown from that mean for single days are of course very wide; but for a whole winter season, which includes the warm days and the cold days and the days on which the temperature is just ordinary, they cannot be wide unless the winter as a whole is a truly extraordinary one.



The heavy line across the center of the figure marks the 50-year average; the severity or mildness of the winter is easily visualized by reference to it

The average temperature of winter for the past 50 years

Extraordinary winters do happen, however; we know it without telling and the graph tells us to clinch the matter. The freak winter of them all was that of 1889-90, when the average temperature for the entire season was 40.7 degrees—nine degrees above the mean and nearly nine above freezing. This winter was flanked on both sides by warm winters, making four in a row for which the thermometer registered an average above the fifty-year figure. Doubtless at that time there was a good deal of hue and cry about the good old-fashioned winter that never happened any more.

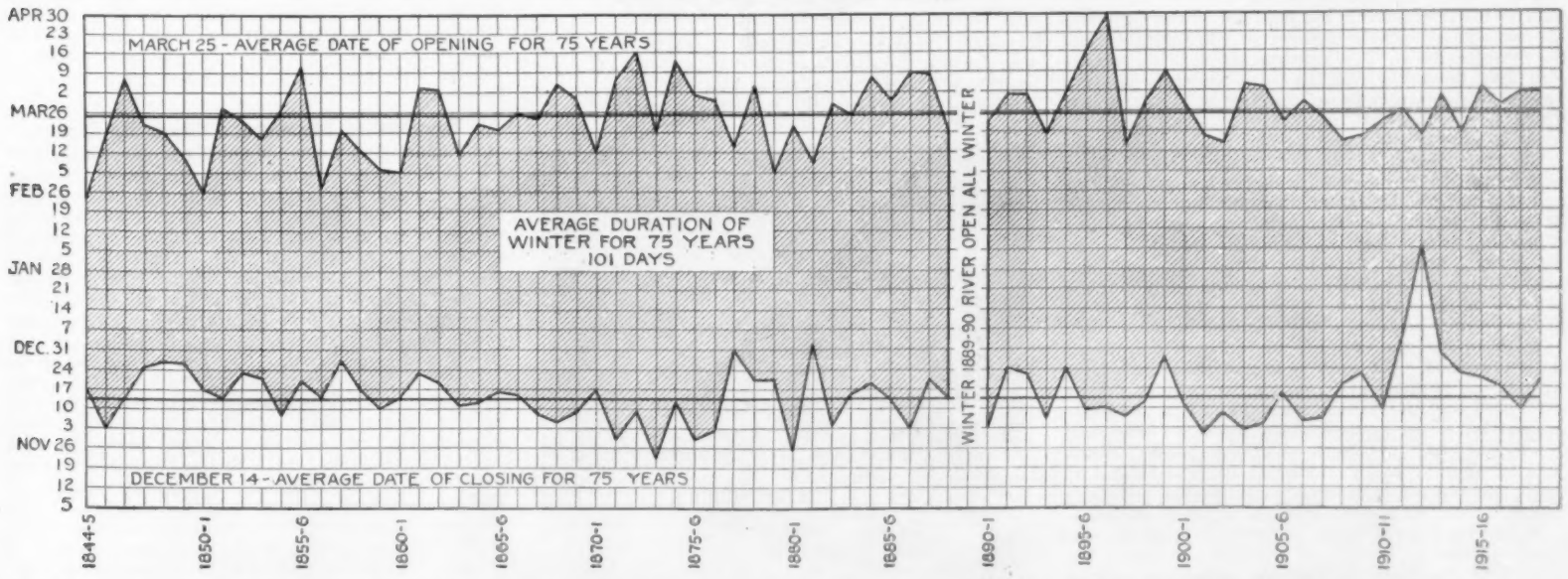
Other warm winters were those of 1879-80, which is long enough ago to rank as an old-fashioned winter with most of us; of 1918-19 and 1912-13, which are recent; of 1877-78 and 1881-82, which might have been taken with that of 79-80 to prove that the kick had gone out of the winters; and of 1905-06, and 1908-09. That of 1879-80 averaged 37.8 degrees; the others were 35 degrees or a bit more. If we recognize the season of 1879-80 as a freak also, and throw it out along with 1889-90, the greatest excess above the 50-year mean shown by the average temperature for any winter is 4.8 degrees by 1912-13. This is an excess of about 15 per cent.

If we look below the mean line for freak winters of another sort, the first thing that we find is the bitter war-time winter of 1917-18, with an average temperature of 25.4 degrees. Almost in the same class were the two successive winters of 1903-04 and 1904-05, in both of which the thermometer would have stayed below the 27-degree mark for the entire season if it had been giving a uniform performance instead of a natural one. We wonder what we were saying during these two years on the subject of old-fashioned winters? And we wonder what the advocate of the old-fashioned winter today will say when he learns that the three coldest seasons ever experienced in New York have all been within the past seventeen years, and that the only winter throughout the seventies and eighties that even approached them was that of 1874-75?

If we are in search of a criterion for throwing out the freak cold winters as well as the freak warm ones, we may exclude these four; and the coldest of the "normal winters" remaining was that of 1881-82, when the average temperature was four degrees below the fifty-year mean—less than the fifteen per cent of normal variation in the other direction. And if we recognize that a winter showing the maximum allowable normal variation is a cold or a warm one, as the case may be, we might reasonably establish a ten-per-cent variation for ordinary winters, and brand as warm or as cold those whose average temperature departs by more than this from the grand average. Then comes the surprise—the present winter, on the basis of its performance to date, is not even distinctly a cold one—it hangs right on the ragged edge between the normal winters and the cold ones! And if the remnant of winter that remains is to modify this in any way, it is pretty likely to raise the average temperature for the season, rather than lower it.

The chart reveals a number of curious things which it is worth while to mention. Consider the period from 1872 to 1882, throughout which the winters were alternately warm and cold. Consider the extraordinary

(Continued on page 261)

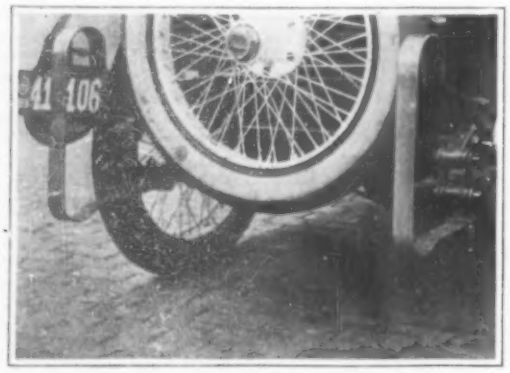


The lower line shows the date at which navigation had to be suspended on the Hudson River between Albany and New York; the upper line shows the date at which the river was open again in the spring; the shaded area between the two lines represents the duration of winter. Note that in 1889-90, judged by this test, there was "no winter."

When winter fell, and how long it lasted, over a period of 75 years

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Arts



A bumper that gives better protection

New Bumpers for Rear of Car

AN innovation in design is that of the rear bumpers for motor cars, that are vertical. Two U-shaped strips of spring steel are so fashioned that they can be secured without much difficulty, to any make motor car by attachment to the springs in the rear. Attachment does not interfere with the springs in any way and gives the rear of the car ample protection from over-ambitious cars in such a location. The vertical rear bumper extends clear of everything in the rear of a car and where a bar horizontal with the road is desired it can be arranged with this design of bumper. —By *K. H. Hamilton.*

Handle and Latch in One

A LOS ANGELES man has combined a latch and handle as shown in the accompanying photos. This is designed for use on windows. It is usual to place the window catch or latch at one point and the handle for opening the window at another. Combining the latch and handle in this manner is much more economical than when they are installed separately, especially if there are a great many windows to be equipped. At the very least it saves four screws on each window.—By *C. W. Geiger.*

Ingenuity and the Ink Bottle

IT has not always been easy for the draughtsman to strike a happy combination between accessibility and cleanliness of his india-ink supply. If he has been anxious to exclude dust effectively, he has had to keep the bottle tightly corked; and then to ink his pen he would be obliged to remove the cork, insert the quill in the ink, and run the fluid out of the quill into his pen—three entirely distinct and dissociated acts. On the other hand, if he tried to simplify the process of getting the ink out of his bottle and into his pen, he was fairly certain to lay the fluid open to the dust which accumulates so rapidly and travels about so freely in all city interiors.

The little device which we illustrate escapes from both horns of this dilemma, none the less annoying in that it is not a vital matter. The ink bottle is tightly closed, but with a cork that swings on a pivot instead of one that is free from all connection with the bottle. The pivot is hinged at the base of the bottle, and connected with a little counter-lever in such a way that the pressure of the wrist on this throws the cork out of the bottle neck and leaves the bottle open.

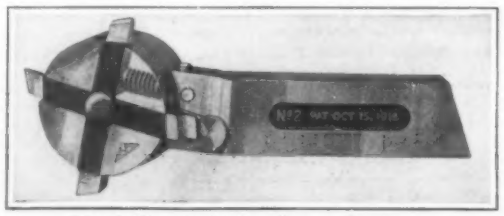
At this point the complete ingenuity of the device stands revealed. The cork is one of those with quill fixed in its bottom; and the relative position of the wrist-lever and the quill is such that while one holds the cork out of the bottle with the wrist, the hand is in exactly the right position to sweep the pen across the point of the quill and load it with ink. So instead of three unconnected operations, one fills the pen from this dust-proof bottle with a single series of motions—a sweep of the arm bringing the wrist down on the lever, followed by a twist of the wrist to secure the ink. The re-corking is entirely automatic, taking place through spring action as soon as the weight of the hand is removed from the lever, so that no forgetfulness can result in an open bottle.

Prolongation of the Life of Turbine Blades

IT has been noted that if attempts are made to clean an iron object covered with lead by the sandblast, the lead covering cannot be removed. It appears that the lead is forced more strongly into the depression in the surface, and becomes tightly held there. It appears from this if the surface of a Pelton blade be covered with lead by the Schoop process, the action of particles of sand upon the blade while it is running will drive the lead on to the surface instead of wearing away the surface of the blade. This method has been used experimentally in Swiss hydro-electrical installations, and practical results will soon be available.

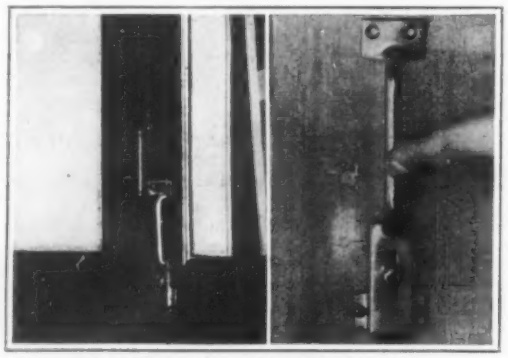
Four Tools at a Time

IN all machine shop production requiring two or more operations there is much needless waste of time in resetting tools. A Cleveland manufacturer has



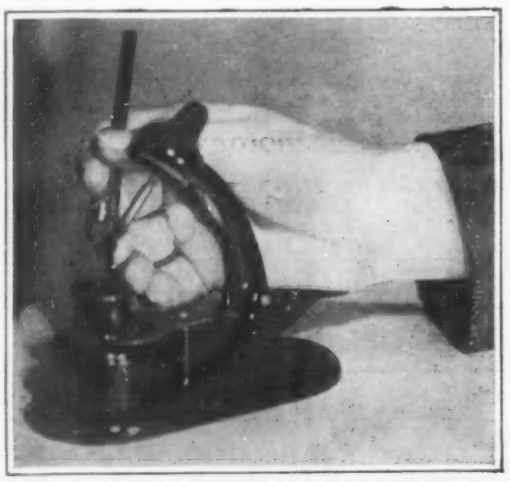
The holder that takes four tools at once

placed on the market a lathe-tool holder which will hold four different tools. After the tool holder has been set up there is no time lost in resetting tool points for one to three additional operations on the work be-



Window handle and latch in one piece

ing done. It is only required to turn the tool desired into position for continued use. A screw device takes care through a ¼-inch adjustment of the wear on the point of the cutting tools.—By *Allen P. Child.*



The dust-proof ink-bottle from which the drawing pen is easily filled

The weight of the kettle turns on the gas

An Ingenious Gas-Saver

THE gas stove cannot help being more economical than the one that burns coal, because no matter how carelessly it is used, there will be times when the user will remember to turn it out during an interval of non-use in which the coal stove would have to be left burning. But in ordinary practice there is a good deal left to be desired as regards the economy actually achieved in burning gas. In the ideal state, the burner would be in flame only when something sat over it to receive its heat. An automatic device for approximating to this condition is illustrated herewith—the invention of an American housewife. In its general scheme of operation it is absurdly simple; the weight of pot or kettle on the burner throws open a valve which allows the gas to burn full force, while with the removal of that weight the valve closes to a point where it cuts off all the gas except an amount barely sufficient to support a pilot light.

A New Tungstenless High-Speed Alloy

A NEW variety of tungstenless high-speed steel has appeared and advantages of both a practical and economical nature are claimed. It is cobalt-molybdenum steel, the cobalt apparently acting as a stabilizer and as correcting certain disadvantages said to exist in molybdenum-tungsten steels. The new steel is claimed to possess the highest point of efficiency ever obtained. The hardening is said to be more definite as well as simpler since the hardening temperature required is only in the neighborhood of 2,000 degrees Fahrenheit. The steel is also reported to machine exceptionally soft and easily. The specific gravity of como steel is reported to be equal to that of the old carbon tool steels and so 10 per cent less than that of the tungsten high-speed steels. As a result it is estimated that a given weight of como steel will produce 10 per cent more tools than the same weight of regular high-speed steel. The new steel is a British invention.

Decreasing Microscope Glass By Heat

A FREQUENT source of trouble in microscope work is the presence of a surface on the slide, which will not permit the spreading of films in an even manner. The fluid breaks into irregular pools upon the surface of the glass, owing most probably to a trace of greasy matter present. In a note on the subject recently published in the English technical press by Dr. W. E. M. Armstrong, bacteriologist at the Central London Opthalmic Hospital, he states that of the many agents he has tried, heat is the only one which acts simply and expeditiously. The heat obtainable in the ordinary dry sterilizer—say at 180° Centigrade—is, he says, not enough, a temperature of several hundred degrees being required. He therefore puts the slides, after washing in soap and water and drying, in a tin box and places this over a Bunsen burner for almost half an hour. A small oven has been constructed for the purpose, provided with trays or drawers. Slides prepared in this manner, Dr. Armstrong says, are more reliable than new ones in regard to the perfection of surface. The films spread in a satisfactory manner and the pattern of distribution is not interfered with. It is obvious that the same process is applicable to other experimental work in connection with photography and so on.—By *A. H. J. Keane.*

Photo Enlargements by Expansion of Negative Emulsion

(*Continued from page 243*)

opinion. However, it appears that the unusual feature of the phenomenon is in the cause of the separation and further chemical reaction of the upper film and not in the fact that the upper film became enlarged. My reason for this statement is based on several reliable authorities, one of whom says, "A process of stripping a film from an ordinary unvarnished negative, *enlarging it* and attaching it to a larger plate, dates from 1882!" The formula for an "enlarging-mixture" is given as follows:

Hydrofluoric acid	1 drm.	31 ccs.
Citric acid	½ oz.	125 "
Glycerine	1 drm.	31 "
Acetic acid	½ oz.	125 "
Water	4 oz.	1000 "

The process, using the above-mentioned formula, is described briefly, viz.: "The negative is placed in the solution and the film (emulsion) will gradually become released from the glass and *at the same time be enlarged.* It is next carefully rinsed in water and floated upon, and squeezed into contact with, a cleaned glass of the required size. In this way a quarter plate (3¼ x 4¼) negative may be expanded to fill a half plate (4¾ x 6½) and larger sizes in proportion."

In looking through the January 16, 1920 issue of *The British Journal of Photography*, I came upon an illuminating communication from Mr. Godfrey Wilson written evidently in answer to a correspondent. Mr. Wilson says, "The process (enlarging negative-films by stripping and expansion) was first advocated, I believe, in 1882. It was boomed in 1891 in which year a commercial preparation was patented. You are right, I think, in saying that the marketed powder consisted of sodium fluoride and tartaric acid; but for home manufacture hydrochloric acid is to be preferred. I made many experiments at the time, and found that a serviceable solution could be made by dissolving a dram of either sodium or potassium fluoride in a pint of water, and then adding a little—say 50 or 60 drops—of hydrochloric or sulphuric acid. On immersing the unvarnished negative—the newer the better—in the solution the film leaves the glass and becomes enlarged about 1½ linear, after which it is washed and floated and dried upon a fixed and washed unexposed dryplate of the required size. About the time this method of enlarging was the craze, a French experimenter stated in the pages of the *Moniteur* that the following solution for film-enlarging could not be beaten:

Hydrofluoric acid	¼ oz.
Citric acid	1 oz.
Glycerine	¼ oz.
Glacial acetic acid	¼ oz.
Water	8 ozs.

All by weight

This formula, it will be noted, includes hydrofluoric acid—the orthodox but very troublesome liquid for stripping films—which other experimenters have in one sense eliminated."

The average amateur photographer may attach little practical value to the formulae and methods involved in this enlarging-process so popular in 1882 and 1891. Nevertheless, I have gone into detail merely to show, by way of contrast, the simplicity, quickness and effectiveness of modern methods. Moreover, the preceding paragraphs may convince the "snap-shooter" of today that there are few "discoveries" that he may come upon in his developing, printing and enlarging experiments that have not been worked out by some thoughtful photographer of long ago. Furthermore, the modern camerist owes it to his own enjoyment of photography to know something of the pioneer-work that has made his hobby of today so simple, interesting and enjoyable.

The Romance of Invention

(*Continued from page 244*)

atoms, the power of the electrons, which travel nearly at the speed of light. We see no way at present; if I had a million dollars for experimental work I wouldn't know how to begin to spend it on that problem. But the solution, if it ever comes, will in all probability come from some purely scientific theory, perhaps as unrelated to the subject of power as the theory of electrical impulses over complex conductors was unrelated to telephony when I worked upon it. Thousands of men may work for hundreds of years before one genius with the flash of inspiration arrives, who will unlock the door to endless power."

Professor Pupin takes out few patents—never until he is sure that what he wants to patent is of value. "I'd rather have a few good children than a lot of poor ones," he phrases it. He prefers to sell his patents outright, rather than to develop them commercially himself, because of a disinclination to be "bothered with business." He confesses, however, to a human pleasure when a patent of his results in practical value to an unscientific world.

Professor Pupin's name is so well associated with electrical matters that it comes almost with a shock to learn that he is interested in the laboratory in matters entirely alien to electricity. His present work is concerned with sound and its propagation, and an investigation into the difference between noise and musical vibrations. This, Professor Pupin believes, is a problem which has never been properly approached, nor in any way solved. The student of physics who has always supposed that musical notes were simple rythmical vibrations, while noises were complex mixed vibrations, is told that neither this nor differences in pitch nor loudness account for the difference in sound phenomena as between music and mere noise. "I rattle a bunch of keys and blow a penny whistle at the same time," says Professor Pupin, "as nearly as possible to make sounds of the same degree of intensity and loudness. You hear them both, while close to me. But if I ask you to walk through my rooms, there comes a place where you hear the whistle quite well but the keys no longer sound. The noise of the whistle on a peanut stand is drowned out by a passing elevated train which obliterates all other sounds, even those of heavy wagons, in themselves much louder than the whistle. But several blocks away you can hear the whistle and you cannot hear the noise of the trains. So I am working with sound and tubes in the laboratory and it may be that my work will be of interest not only to scientists"—Professor Pupin's eyes twinkled—"but to commerce, too. The investigation may open the way to the obliteration of noise in the phonograph—an essential of modern education—and to elimination of noise in the telephone."

Professor Pupin is also working on a new method of using dynamo current in place of storage battery current at the telephone centrals. Storage batteries are expensive to buy and maintain. Generators would be much more satisfactory if it were not for the fact that one hears them when their current is used for telephony. Professor Pupin does not discuss this as yet, but refers to it as a junction of sound and electrical experiments in the laboratory which may have an important bearing on the practical operation of the telephone exchange.

Professor Pupin's scientific work has been catholic in the extreme. He differed with the Edison interests in the early history of electricity in the commercial field, and advocated alternating currents instead of direct currents for general distribution. Time has proved him correct. He was first in this country to follow up Roentgen's discovery and the first X-ray photograph for surgical work was made

by him in 1896. X-rays, however and Professor Pupin's health did not get along well together and preferring to be a healthy scientist to a badly burned X-ray-ist, he turned his attention to what became the "Pupin coil." He has made many other contributions to radio telegraphy besides the theory of the receiving apparatus; an elimination of "static" is one of the problems to which he has devoted much time.

Professor Pupin is a mathematician of note, yet he refers to mathematics in his own hands merely as "tools." "Perhaps," he said, "If I had no laboratory, I would still attempt discovery in science only with a pencil and a sheet of paper; but there are so many other problems of more interest to me than the development of this tool that I leave that to others."

Perhaps the greatest work which Professor Pupin has done has never been patented, never put on paper, never formulated as a theory, never made evident to the public . . . nor is it likely to be. Columbia University has given Professor Pupin practically a free hand. He has as little irksome class room work to do as possible and his original work in the laboratory Columbia considers as of infinite worth to her as a University. But Professor Pupin's work in the laboratory which has perhaps done the world the most good is the work he has made others do—the development and instruction of many students, who have carried on work under him, the inspiration he has been to others and the influence he has had upon those who have begun their scientific careers in his classes. For Professor Pupin has that unusual combination of intellect raised to the *nth* power, plus a personality and a vividness of character which make him a power as a teacher. There is nothing "professional" about Pupin. He has balance, sanity, a sense of humor. If he looks at science scientifically, he looks at human beings humanely (which is not always easy to do). There is none of the pedantry of the pedagogue about him, and he is as gluttonous for work himself as he is for having his students work.

Professor Pupin is enthusiastic over the country of his birth, and the ideals, aspirations and ability of the Serbs. He is active in Serbian movements and interest in this country. But he is an American citizen and proud of it, and his work during the war included membership in the National Research Council, and its Executive Committee and of the National Advisory Board for Aeronautics.

Honors, of course have come to him thick and fast. The Tyndall Fellowship, his professorship at Columbia, an honor degree from Johns Hopkins, presidency of the New York Academy of Science, membership of the Council of the National Academy of Science, the Elliot Cresson Medal for distinction in physics, the Hebert prize of the French Academy in physics, the gold medal of the National Institute of Social Science—of what use to catalog what other men and other bodies have thought of him? His reputation rests upon what he has done, is doing, not upon the recognition others have given to that doing.

It would be sufficiently easy to carry this sketch to many pages—the early struggles, the scramble for money with which to get an education, the studies abroad, the work with Professor Crocker at Columbia, when that scientist taught the practice and Pupin the theory in the newly established course in electrical engineering; but then it would be no longer a sketch and become an article for an encyclopedia. If readers who have arrived at this point conceive Professor Pupin as a very finely working brain atop a very sturdy body, inhabited by a real man instead of a pedant; if they are able to visualize Professor Pupin as one to whom all science is an altar, on which he offers the devotion of a keen brain intent upon knowledge for the sake of

knowledge, while convinced that abstract knowledge some day—tomorrow, next year, a thousand years from now—must be of value; if they finally see him not only a producing human engine in himself but as an inspiration and a driving force which has been the foundation of the success of hundreds of students: this sketch will have been truly drawn.

Commercializing the Coyote

(*Continued from page 246*)

Piute Indians, who are becoming active and are landing a share of the spoils.

The pine marten is similarly taken far up in the heaviest timber. This is a light, long, slender animal, a beautiful brown, and its fur is worth $50, the price having doubled in two years. Mink, badger, ermine and skunk are surprisingly plentiful in the canyons and along the streams even into the valley towns, such as Bishop and Independence, where housewives frequently put out traps and provide themselves with prized coats, collars and muffs. The lowly skunk brings the trapper $5, is readily caught, and seems to increase in number from year to year. Much talk is heard of silver fox and skunk farms in the Owens Valley, but nothing tangible has been done in this direction.

When the daughter of a late President made her appearance six or seven years ago in a magnificent coat of real lynx skins she opened a new field to the Mt. Whitney trappers. The fur at once became inordinately popular. It was so costly, however, that she without ducats to burn naturally resorted to imitation. Nearest to the genuine article in appearance is the lynx cat, to which no attention had been paid but the price of which has gone from nil to $15. It is twice the size of the bobcat, equally common, and will be a rather easy source of revenue until some other fad shall displace it.

Before autumn is well advanced below, the hardy trappers with saddle and pack horses, dogs, and all supplies, go into mountain winter quarters and enter upon a campaign of hard work, peril and adventure such as only the most thoroughly seasoned men can withstand, particularly at these high altitudes. Each has a "line" of traps stretched over perhaps twenty tortuous miles, and this distance he covers day after day, on horseback, snowshoes or skis when the vast snowfields reach the engulfing stage. At any moment he may pay with his life for the harvest he is reaping. A crevasse—for here are eternal glaciers—may swallow him forever, or a slip of his horse's hoofs or his own feet pitch him into eternity. It is a strenuous game even where conditions are favorable.

When spring approaches the trappers see fun ahead. Early in April the bears, brown and black, begin to emerge from their winter lairs, 7,000 to 9,000 feet skyward, and the huntsmen turn to them for sport with rifle and dog, the Airedale being the most effective. Often the bears come down the cattle trails and are shot before the dogs get near them, but in the chaparral furious battles are fought. Many dogs are literally hugged to death or torn into ribbons. Last spring a wounded bear came near "getting" Tom Key, who has hunted them nearly half a century, and states frankly that it was his first and only critical experience. Given the chance Bruin will amble away and mind his own business like a gentleman, but if pressed he stands ready to fight to the finish. His skin, if extra good, is worth $100 for a rug or robe, but the ordinary one only $35. The meat spoils quicker than any other, no matter how cold it be kept, but the lard is declared to be the best in the world for cooking purposes and invariably is preserved as a delicacy. For big game in these mountains trappers and others prefer the 30-30 rifle.

Bears were especially plentiful in the Minarets region and the vicinity of the Devil's Postpile last fall and will be watched for there a few months hence. The "postpile," a national monument, probably is the most curious basaltic formation on earth—a mass of magnificent columns sixty to seventy feet high above the surface and no man knows how long beneath, each column form eighteen inches to three feet in diameter. Some are perfectly straight, others twisted in the making, as a stick of pliable candy might be shaped, and at one point they have the wavy appearance of flowing water. Really it is a series of several piles, the largest a quarter mile long, with huge trees upon and about it. The prisms are five or six-sided, dark gray, green or glistening black. Earthquakes and freezing have wrought havoc with the columns, breaking them off and toppling them. The impressive array of solid piles is now skirted, more than ever, by enormous heaps of fragments of all sizes, like ruins of ancient buildings—nature destroying the marvelous works of her own secret creative processes.

Ugliest of all the animals encountered in that wonderful game area is the wolverine, closely resembling a small bear but much more powerful. This beast is credited with the ability to vanquish a grizzly but there is no record of a witnessed combat and the possible result must remain a matter of conjecture. The wolverine is aptly described as "crazy as a bat." On occasion it will make a mad, blind rush regardless of obstacles or consequences. Recently a power company drove a long tunnel under the Sierra Nevada to carry a stream for hydroelectric development. One morning a party of miners entering the bore saw a pair of blazing eyes in the darkness ahead reflecting the glare of their lanterns. They expected the owner to turn and run away. Instead it came dashing toward them, knocked one man off his feet and sent him sprawling, frightened the others almost speechless, and kept going. It was a big wolverine and its action was characteristic. This creature's hide brings only $15 and nobody's looking for it. Dogs find it uncompanionable—it "breaks 'em all up" to come in contact.

With fur hunters and government trappers constantly pursuing the animals of prey the mule deer, always numerous, have increased amazingly and winter storms drive them to the valleys in herds of hundreds. One mountain lion kills more deer than twenty average hunters, but the lion, too, is energetically hunted, being worth from $25 to $45. Man ultimately preys upon all the rest.

Wreck-Proof Safe for Ocean-Going Mail

(*Continued from page 247*)

ship with the deck on which the cradle is fastened sinks to a considerable depth below the water. In this case the safe is released automatically. It makes no difference how the angle of the ship's deck is when sinking, the safe will be released smoothly; and even when sinking in a rough sea, no hurt to the safe gliding off the embrace of the arms of the cradle is possible.

The safe, during the voyage of the mail steamer, is located on the ship's deck in full view of the bridge, so that the officer on duty can constantly keep a watchful eye upon it in case thieves on board should attempt to break in. Besides which, as a further safeguard, it is connected with the dynamo of the vessel so that any person not knowing the wiring and touching the outside will either start a signal or get severely hurt. At no time are passengers on the ship allowed near the safe, being warned to keep away by printed signs and the verbal orders of the crew of the ship.

The shape is oval to prevent wreckage from attaching itself to the safe and to give it great strength and also because

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UNDARK

Radium Luminous Material

"I Want That on Mine"

THE man or woman whose watch has an UNDARK dial can tell the time as readily at midnight as at midday. They don't have to light matches, or go without knowing the time even on the blackest night.

The same convenience of UNDARK is also being applied to clock and instrument dials, electric buttons and other switches, chain locators, push buttons, locks, house numbers, pistol sights, novelties, etc.

UNDARK doesn't get dark in the dark

It is a factor for safety on gasoline gauges. You want it on yours—and increasing numbers of manufacturers are daily announcing their use of UNDARK.

UNDARK contains real radium and is self-illuminating without exposure to light.

The Radium Luminous Material Corporation is a large miner and refiner of radium-bearing ore and the pioneer manufacturer of Radium Luminous Material in this country.

The Trade-Mark UNDARK is your safeguard in securing the wonderful natural service of radium. Ask for UNDARK by name.

You will say, "I want that on mine!" the instant you realize its convenience.

Our service of instruction and inspection encourages the application of UNDARK by the manufacturer in his own plant.

Radium Luminous Material Corporation, 55 Liberty St., New York

Factory: Orange, N. J. Mines: Colorado and Utah

Trade-Mark Name UNDARK Reg. Applied For

Wreck-Proof Safe for Ocean-Going Mail

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it floats better in this form. The safes float on the bulkhead principal and the greatest care is taken in their manufacture to prevent any possible leakage of sea water. They are made without riveting and all joints are welded and hammered. In case of fire on board ship the safes are made to withstand a tremendous heat without melting or injury to the contents. They are really constructed of three different sheets of specially made steel, each built inside the other, giving the safes greater buoyancy and security.

When a shipwreck occurs and a safe with its precious contents is cast adrift on a stormy sea, it is by no means a helpless floating object. On the top or deck of each safe is a complete signal apparatus, which when the safe is thrown overboard and cast adrift from its cradle gets to work automatically one-half hour after the safe floats, showing a bright light every fourth minute for one minute just like a miniature lighthouse. But this is not all, as every ninth minute a signal horn sounds for one minute. These operations will keep up during three months, should the safe remain afloat that long without being found, while in addition to them for twelve hours after the safe leaves the ship a rocket is set off every hour.

After the postal authorities at a Dutch port have put the mail in a safe it is closed with two or more covers provided with special locks and keys. But the safety of the contents does not end here, as should the safe be cast afloat a device fastens the innermost cover so that it can only be opened by using a postal secret code. Finally every safe is provided with one separate compartment which automatically destroys all its contents should an unauthorized person attempt to open the safe. In other words the safe is as nearly a human guardian as it is possible to make an inanimate object.

So that the Dutch public may profit by the use of the floating safes special stamps have been issued by the Dutch Government. These stamps are now on sale at postoffices all over Holland, and one of them attached to a letter or package entitles it to be placed in the safe during the sea voyage.

The captain on board every ship carrying a mail safe is provided with keys to the safe and during the voyage should any of the passengers desire to place mails or valuables in the safe, they can do so by paying a small fee. All such parcels must also bear the special stamps to be purchased on board ship, and the address where the valuable are to be sent when the safe is found and opened in case of shipwreck.

How the Chinese Make Their Beautiful Enamel-work

(*Continued from page 247*)

takes fine strips of copper, each strip being about a sixteenth of an inch wide and about the thickness of stout paper. These he glues *edgewise* upon the black outlines of the pattern on the bronze vessel. The wire must follow the design with absolute accuracy, down to its finest detail, each curve being perfect, and each angle sharp. Infinite patience and skill are required, for it often takes months to execute an intricate design. The glue used to attach the wires to the vessel is prepared from the roots of orchids.

When the wirework is completed the whole pattern has been outlined in strips of fine copper, which form the cells, or *cloisons*, in which the pigments are afterwards placed. It is from the cloisons that the work takes its name—cloisonné-work.

Having got the wires attached, the next thing is to cover the whole surface with a kind of solder. To do this the enameller carefully brushes the vessel over with a mixture of silver filings, copper, and borax. He places an iron ferrule around the top and bottom rims to prevent warping, encloses the whole in an iron wire cage and packs it around with charcoal. Then he fires it for about fifteen minutes, controlling the heat by the skillful use of a fan, which he holds in his hand. At the end of the firing the mixture on the outside has fused and the surface has been coated all over, perfectly, with the silver alloy.

The artisan now brushes the surface with an acid preparation made from apricots, and it is then ready for enamelling.

Working to the colored sketch, our Chinese workman, with a small iron trowel, packs the wire cells, or cloisons, with pigments in paste form, until each cell is filled with its appointed color. Then he fires the work again, in the same way as before, this time for about ten minutes. When the vase is taken from the charcoal fire the pigments have shrunk into the wire cells and have acquired wonderful brilliancy. But bubbles have appeared to mar the surface. The workman takes the vessel in his lap, and patiently breaks every tiny bubble with a small hammer and a sharp-pointed nail, and fills the holes with more color.

The coloring and firing process is repeated until the pigment, after firing, is level with the top of the wirework. It may have to be done as many as eight times on fine work, each time entailing the repairing process.

After the final firing the vessel is put on a lathe and polished, first with a file, then with sandstone, and finally with charcoal made from lime trees.

The finished vessel has a wonderfully brilliant surface upon which the wire pattern can be seen, clear and sharp, in the most beautiful tracery. The delicate coloring, which will last as long as the bronze itself, shows the touch of the real artist-craftsman.

The Japanese first invented the process upon metal, and the Chinese learned the art from them. However, the Chinese went one better; they found out how to do cloisonné-work on earthenware. And to this day they are the only people who know how. Nobody else knows how to attach the copper strips to the pottery so that they will stand firing.

Putting Infra-Red Rays to Work

(*Continued from page 248*)

experiments with carbon arcs in order to increase the infra-red radiations. Special incandescent lamps have been studied and experimented with in seeking suitable illuminants for the small portable sets used in field work. These lamps are of the nitrogen- or neon-filled type, in order to withstand a heavy current and give forth an intense white light. The filaments, of extra large diameter, are made in the form of a helix, so as to concentrate the rays. A current of 6 to 8 volts is employed with such lamps.

The parabolic mirrors employed in the infra-red signalling system are made of gilded bronze or silvered glass. The focal length of these reflectors is approximately half the diameter, if an arc is employed; but if an incandescent lamp is used the reflectors have an even more pronounced curve.

All the transmitting projectors are provided with quick-acting shutters which are used for chopping the rays so as to form the short and long flashes of the Morse code. Both the transmitter and the receiver are provided with a sighting tube which lies parallel to the rays of invisible light, and aids in alining the stations for proper communication. Obviously, the two stations must always be within plain sight of each other, with no intervening obstructions.

Since the range of the transmitter is proportional to the diameter of the reflectors and the amount of light, all other things being equal, the French army has introduced various models and sizes of infra-red transmitters. The small portable transmitters, for work in the front

line and accordingly intended for very short distances only, say not over two-thirds of a mile, have a searchlight about 11 inches in diameter and operate with a 40- or 50-watt incandescent lamp. A storage battery supplies current for the incandescent lamp.

For greater distances, say one to two miles, the same projector is employed but with an arc lamp substituted for the incandescent lamp. For still longer distances, say from three to eight miles, the standard searchlights of the army and navy, measuring from 20 inches to 50 inches in diameter, are employed. The detector member is placed in front of the searchlight mirror for receiving purposes, so that the same searchlight is made to serve the dual function of transmitter and receiver.

The receiving station of the infra-red ray telegraph consists of a parabolic reflector, at the focal point of which is mounted a detector. In one system, known as the Charbonneau, the detection and reception of the infra-red ray signals is accomplished by visual means, while in the Herbert-Stevens and Larigaldie system the signals are detected by audible means.

In the visual or Charbonneau system of reception, a ribbon of paper coated with sulphur of zinc and giving forth a green phosphorescence is unrolled before a mirror. The light from a 10-volt lamp, specially filtered by means of a liquid color filter permitting only the luminous rays of high frequency to pass through, brilliantly illuminates that part of the ribbon on which it falls, and excites the phosphorescence. The infra-red waves, broken up into Morse signals at the transmitting end, are received by the mirror and concentrated on the paper ribbon, with the result that they become visible in the form of dark dots and dashes, since these rays tend to dim the phosphorescence. A special arrangement of the apparatus permits the visual means of detection to be employed even in broad daylight.

The audible method of detection is of two general kinds: First, the direct audible detector, which, while simplicity itself, does not permit of amplification and hence limits the range of the infra-red transmitter; secondly, a thermoelectric arrangement which, while quite complicated, permits of many stages of amplification and therefore the maximum range.

The direct audible detector calls for a diminutive horn connected by flexible rubber tubing to a pair of ear pieces. This diminutive horn, a cross-sectional view of which appears in the accompanying line drawings, is placed at the focal point of a parabolic mirror. The horn is provided with a window or disk of quartz, facing the mirror, while the interior is heavily coated with lamp black which, as is well known, absorbs visible and invisible rays in a most efficient manner. The operation of this detector is simply thus: the infra-red rays pass through the window into the interior of the horn, where they are absorbed by the lamp black. The heat of the waves serves to heat the air confined in the horn and rubber tubing, with the result that said air expands and contracts according to the varying degree of heat. This expansion and contraction affects the ear drums. In this manner the infra-red signals are made audible and can be read by the operator. Obviously, such a detector does not readily lend itself to amplification of signals in its present form, although it has possibilities that may be worked out in the future. This detector works well for infra-red ray telephony—the telephone modification of the system—and short distances have been covered with it.

The second method worked out by Messrs. Herbert-Stevens and Larigaldie consists of an electric thermopile placed at the focal point of a parabolic reflector. The current produced by the thermopile, as a result of the infra-red rays concentrated on it and producing heat, is broken up by a tikker or interrupter mechanism, similar to that employed in radio telegraphy for the reception of undamped waves, so as to produce a musical note of good audibility.

The thermopile in this instance presents numerous serious problems. It has to be extremely sensitive yet instantly and variably responsive; that is to say, it must have practically no electrical inertia. One of the most efficient thermopiles for this purpose consists of a metal plate 0.01 mm. thick which is sealed by autogenous fusion on the point of a crystal of great thermoelectric power. The thickness of the plate and the diameter of the point of contact are as small as possible, so as to give an arrangement of very small heat capacity. The best results have been obtained with platinum and a crystal of tellurium. A glass cell is used to contain the two elements and is provided with a fluorite window. The thermoelectric couple is connected to a valve amplifier in the manner shown in one of the accompanying line drawings, which is self-explanatory. A potentiometer is included in the circuit in order to eliminate any currents due to local conditions causing temperature variation of the junctions. The thermopile is mounted in a bulb very much after the fashion of an electric lamp, and the air is exhausted. In this manner the heat is conserved. A bayonet socket arrangement for the base of the thermopile lamp unit permits of removing and replacing a unit with little trouble.

The Heavens in March, 1920

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above Orion in the west, and Canis Minor above Canis Major in the southwest.

The Planets

Mercury is an evening star till the 20th, and a morning star afterwards. He is best visible at the beginning of the month, when he sets at 7:15 P. M. Venus is still a morning star, rising about 5:10 A. M. in the middle of the month. Mars is approaching opposition, and rises at 10:30 P. M. on the 1st and 8:30 on the 31st.

Jupiter is in Cancer, and crosses the meridian about 9 P. M. in the middle of the month. Saturn is in Leo, and "souths" at 11 P. M. on the same date. Uranus is a morning star, too near the sun to be observable. Neptune is in Cancer, and observable in the evenng.

The moon is full at 5 P. M. on the 4th, in her last quarter at 1 P. M. on the 12th, new at 6 A. M. on the 20th, and in her first quarter at 2 A. M. on the 27th. She is nearest the earth on the 24th, and farthest away on the 12th. During the month she passes near Neptune and Jupiter on the 2nd, Saturn on the 4th, Mars on the 8th, Venus and Uranus on the 18th, Mercury on the 20th, and Jupiter and Neptune once more on the 29th.

Jupiter and Neptune are in conjunction on the 29th, Neptune being 58 minutes of arc north of his great neighbor. This will afford an excellent chance for observers with small telescopes to identify the remotest of the planets.

Princeton University Observatory, Feb. 19, 1920.

What About the Old-Fashioned Winter?

(*Continued from page 253*)

leap between 1917 and 1919, from the coldest of all winters to the third warmest—and back again to one that lies comfortably on the cold side of the median line. Consider the decade from 1905 to 1915, when the winters might be characterized as ruling warm throughout. And against this consider the period from 1885 to 1903, in which there was but one winter that got appreciably below the grand average. All this forces us to conclude that the distribution of cold and warm winters has not changed

perceptibly during the past fifty years—that as far as temperature is concerned, winter is just about the same proposition that it has always been.

What, however, of snowfall? Are our memories of vast drifts and of falls that kept the entire landscape buried beneath feet of snow for weeks at a time also illusory? We shall probably have to admit that they are—that the vivid impressions of childhood, with the fact that things properly look larger to a child than to a man, are responsible for our tendency to put all the snowstorms of merit back in our early days. The graph tells us that this is the case, and we must believe it.

Variation in snowfall is far more conspicuous than that in temperature—partly because we are here dealing with aggregates rather than averages. We find our extremes in the winter of 1892-93, exceeding by nearly 20 inches its nearest competitor, and that of 1918-19, in which it was all the weather man could do to find any snow at all. If we throw out the five snowiest winters and the five most open ones, the extreme variation of those remaining will be about 14 inches above the mean of 35.2, and about 13 inches below it—roughly, 40 per cent in both directions. Perhaps, then, in our effort to strike a point where the normal winter ends and the snowy or open one begins, we might set a variation of 25 per cent as the boundary line.

When the graphs on this page were drawn, we had had this year 36.5 inches of snow. Since then we have had enough to bring the total up to 40 inches; and doubtless we shall have a little more before we are through. Again we find the current season right on the line of demarcation, this time between the normal winter and the snowy one.

As regards the superstition of the old-fashioned winter, the chart, while it does not go back so far as the temperature graph, shows about the same state of affairs. We have always had snowy winters—from the 50 inches of 1886-87 to the 50 inches of 1916-17. We have always had open winters—from the 22 inches of 1888-89 to the 3¾ inches of 1918-19. We have always had successions of open winters—we have always had successions of snowy winters. Doubtless we always will. If the fellow who was passing through the growing-up stage in the eighties insists on remembering the snows of 1886-87 and 1887-88, and forgetting those of 1885-86 and 1888-89—as it is only human for him to do—he will talk reminiscently of the old-fashioned winters. The fellow who is growing up now, and who remembers the snows of 1915-16 and 1916-17, and the cold weather of 1917-18, forgetting the joke winter of 1918-19, and remembering how everything was tied up the next year, will do the same twenty or thirty years from now. But—in the long run, winters average up just about the same.

Our third diagram shows the same thing from another angle. The figures of temperature and snowfall tell us nothing about the duration of winter, for the one is for a calendar period while the other is for whatever of winter we had. The best test that we can think of for seeing how early winter fell and how tenaciously it hung on is to be found in examining the time during which it was able to hold its icy grip on some large body of water. We have chosen the Hudson River for this purpose—simply because the records are convenient. Navigation of this stream "closes" when the ice becomes impassable at any point between New York and Albany. It "opens" again in the spring when it is again possible to steam the entire 145 miles between these cities. If anything, this gives winter an undue advantage in the "dope," because local conditions can operate to close the river. But let us see what the "dope" tells us.

The most noticeable feature of this graph is the way it bears out the temperature chart. The latter tells us that for the winter months of 1889-90 the average temperature was more than 40 degrees—eight above freezing. Now really, this sort of a performance is not winter at all; and if we glance at the Hudson River, it tells us that we actually had no winter during this season—the river was open throughout the season that should have been winter.

The average date of closing of navigation—the average date on which winter weather descended over the Hudson River Valley—for 75 years was December 14th. The earliest date was November 22nd (1873); the latest was February 6th (1913), and on two other occasions the river was open through the old year—not mentioning the year when it stayed open. The average date of reopening in the spring is March 25th; the earliest is February 24th (1845), and the latest was in 1897, when the grip of winter was not broken until April 29th. The average duration of winter, according to this test, is 101 days; the longest winter was that of 1896-97, 140 days and the shortest—barring the winter that didn't happen at all—was that of 1912-13, lasting but 82 days after it began in January. And if we examine this graph critically, we shall see that the long and short winters are distributed at random, and fall just as freely in one period as in another.

Vermont Talc

IN the Vermont district there is only one mine at present producing talc of a grade suitable for the cutting of metal worker's crayons. At this mine, which is near Waterbury, there is found in pockets a massive variety of talc which may be used for pencils. This talc is sometimes sorted out underground, but usually is picked from the belt conveyor which carries the crude rock from bins to the crusher. The blocks of talc are taken to the sawing rooms and squared off on two opposite sides on an 18-inch circular saw. This saw is on a swinging arm which is pulled forward by hand, cutting the talc block which rests on a horizontal saw table. The faced block is then sawed with an 18-inch slab saw into slabs of the width of the pencils to be made. The slab saw and the pencil saws are circular saws revolving in a fixed position and the talc is pushed through by hand. The thin slabs are cut into the various sizes of pencils with 12-inch and six-inch saws. Care is taken that the grain of the talc runs the length of the pencil. After sawing, the pencils are sorted into two grades, No. 1 and No. 2. No. 1 grade must be sound and perfect in every way. No. 2 grade may be rougher and slightly splintered at the ends.

Talc pencils at this mill are made in a number of sizes. These are packed in small wooden boxes and the boxes shipped in large crates or cases. The trade prefers a hard, tough pencil to a soft one as the point wears down less easily.

During the winter months trouble was experienced with talc pencils which were made up and shipped without much drying. They were soft and broke easily. It was found that a thorough drying and seasoning increases the durability. It is thought possible that a slow baking or draying by artificial heat might improve stock not otherwise suitable for cutting.

Small blocks or cubes of soft, pure talc are used in a number of industries for polishing wood and nails. In the manufacture of small turned-wood novelties and tool handles blocks of talc are sometimes placed with the articles to be polished in large wooden tumblers revolving about a horizontal shaft. The tumbling of the talc blocks against the wood abrades the talc, filling the pores of the wood and imparting a dull polish. The tumbling of blocks of talc with nails in a similar manner is said to facilitate the passage of nails through nailing machines used in the manufacture of wooden packing cases.

NEW BOOKS, ETC,

THE HEALTH OF THE TEACHER. By William Estabrook Chancellor. Chicago: Forbes and Company, 1919. 8vo.; 307 pp.

Efficiency need not be looked for where health is absent; neither can the inefficient teach efficiency. In this plain-speaking book Dr. Chancellor tells how to increase health and ability for the daily work, how to guard against tendencies to disease, and how to develop a new joy in life and the life-work. Medical training and experience show themselves in every page, and the treatment is thorough. The book fills a need hitherto unsatisfied, and fills it well.

PSYCHOLOGY FROM THE STANDPOINT OF A BEHAVIORIST. By John B. Watson. Philadelphia and London: J. B. Lippincott Company, 1919. 8vo.; 429 pp.; illustrated.

Behavioristic psychology opens to the key of scientific observation, no matter who holds the key; the author, Professor of Psychology in the Johns Hopkns University, escorts the young student through the doorway and into the fascinating realm of human action, response, and habit. He classifies observational methods, passes receptors, muscles and glands in illuminating review, and has significant things to say of instinct and emotion and of personality and its disturbance. Such chameleon-like words as sensation, perception, will, and image, that so largely take their color from individual preconceptions, are strictly avoided, and scope and treatment have been kept within the needs of the American school public.

APPLIED SCIENCE FOR WOOD-WORKERS. By William H. Dooley, B. S., A.M. New York: The Ronald Press Company, 1919. 8vo.; 457 pp.; illustrated.

Like its companion volume, "Applied Science for Metal-Workers," this first covers general principles common to all industry, and this general presentation is identical in both texts. The treatment then narrows itself to provide a body of working knowledge for students of the fundamental trade of wood-working, and seeks to develop the mind to a point where theory and practice become balanced and mutually helpful conceptions. Leading firms have contributed to the success of the work by furnishing cuts and information, the suggestions of qualified teachers supplement the author's own good judgment, and the result is an elementary course of strong appeal for secondary, technical and vocational schools.

THE MYSTERY OF SPACE. By Robert T. Browne. New York: E. P. Dutton and Company, 1919. 8vo.; 395 pp.; illustrated.

It is not to be expected that any book can extract the mystery from that mystery of mysteries, Space; but in profundity of thought and comprehensiveness of treatment this work is the best we have seen. The growth of the hyperspace movement from its birth in the parallel-postulate labyrinth is closely followed, and is examined in the light of the evolution of new psychic faculties. Mathematics is used as "the divining rod of the intellect" and the author foresees the opening of a new era of power that shall be psychic rather than intellectual. His sidelights on the fourth dimension, consciousness, and realism carry us forward even though they necessarily halt on the hither side of demonstration.

SCHOOL OF PRACTICAL ELECTRICITY. By O. Werwath, E.E. Book II. Fundamentals of Continuous Currents of Electricity. 373 Broadway, Milwaukee, Wis.: Electroforce Publishing Company, 1919. 8vo.; 133 pp.; illustrated.

The eight lessons of this text for classroom, laboratory, or daily reference carry the student from nomenclature to electrical heating and its practical application to cooking and household appliances, with a study of costs. On the road between this starting point and objective are well-focused expositions of basic electrical units, mechanical and electrical work and energy, circuits, meters, and resistance measurements. The fundamental principles of direct current are set forth in simple diction, logical arrangement, and comprehensive treatment.

HOW TO MAKE AND USE GRAPHIC CHARTS. By Allan C. Haskell, B.S. New York: Codex Book Company, Inc., 1919. 8vo.; 539 pp.; illustrated.

Within the covers of a single volume, the seven distinct functions of the graphic chart are illustrated and described; so that whether the problem be one of computation, comparison, plotting, recording, demonstration, prediction, or notation, the reader may readily master the principles, and make actual conditions visible in line and curve. From the instructions may be learned the kind of chart demanded by conditions, and a convincing dia-

gram of these conditions may be plotted; a clearer understanding of sales expense, operating costs, and labor turnover is within reach of any manufacturer, and scarcely a business or occupation exists that may not benefit by the adoption of this optical method so lucidly set forth by the author.

MENDELISM. By Reginald Crundall Punnett, F.R.S. New York: The Macmillan Company, 1919. 12mo.; 219 pp.; illustrated.

Mendel's work and accomplishment, and recent developments and theories, are ably set forth in this small volume. Considerable space is devoted to American research by way of the fruit-fly, *Drosophila*, and to the bearings of the material basis of the chromosomes on the phenomena of heredity. From the instructions given the reader may repeat Mendel's experiments for himself, and all phases of the subject are considered. The fine plates, many of them in natural colors, further conduce to a ready grasp of the essentials.

THE WORLD ALMANAC AND ENCYCLOPEDIA. 1920. New York: The Press Publishing Company. 8vo.; 912 pp.; illustrated.

In the consolidated information offered by this indispensable annual many new subjects are this year introduced. The new laws, prevailing industrial conditions, and latest war statistics are readily turned to, and science, particularly applied science, is dealt with under many classifications. For trade and commerce there is a comprehensive set of statistics of the greatest comparative value. Our scientific and educational institutions receive adequate attention; financial conditions are accurately reflected in numerous tables; the German peace treaty is given in full; and the chronology of noteworthy events occupies 56 pages. It is impossible to give any idea of the amount of miscellaneous information packed within the covers.

FOOD FOR THE SICK AND THE WELL. By Margaret J. Thompson, R.N. Yonkers-on-Hudson, N. Y.: World Book Company, 1920. 12mo.; 82 pp.

Upon the discriminating selection and right preparation of food depends in a great measure the continued health of the healthy; in sickness, recovery often hinges upon proper nourishment. This little book of suggestions and recipes by one who knows her subject from A to Z is addressed to the housewife, the physician, and the nurse. The final pages are devoted to treatments—the bath, pack, rubs, poultices and plasters.

THE STUDY OF THE WEATHER. By E. H. Chapman, M.A., B.Sc. Cambridge, England: The University Press, 1919; New York: G. P. Putnam's Sons. 8vo.; 131 pp.; illustrated.

Primarily intended as a school text, this simply-worded explanation of weather phenomena will also prove acceptable as an introduction to the study of meteorology. It provides a series of practical exercises involving outdoor observation and diary writing. The examples and illustrations are taken from British conditions but, as the author remarks, modern meteorology needs some world-wide basis of international coöperation, and the book provides an interesting comparison with our own observations and methods.

DISEASE DIAGNOSED BY OBSERVATION OF THE EYE. Compiled by Dr. F. W. Collins. Part I., Volume I. 122 Roseville Ave., Newark, N. J.: Mecca Supply House, 1919. 8vo.; 122 pp.; illustrated.

The basis of this text is the claim that disturbances, lesions, or pathological conditions in any part of the body are indicated by the appearance of flecks or discolorations in a corresponding part of the iris. The theory is presented at some length, and is illustrated by numerous charts in color.

HOW TO MAKE LOW-PRESSURE TRANSFORMERS. By Prof. F. E. Austin. Hanover, N. H.: F. E. Austin. 12mo.; 22 pp.; illustrated.

Facts of design, construction and operation of small transformers for experimental purposes are stated in such manner that these may be constructed by anyone at small cost, in a variety of pressures and outputs. A new and simple form of core is described, and the amateur will derive much help from the instructions.

IRON BACTERIA. By David Ellis, D.Sc., Ph.D., F.R.S.E. New York: Frederick A Stokes Company, 1919. 8vo.; 179 pp.; illustrated.

The praiseworthy aim of the author is to draw in outline our present knowledge of a group of organisms that are theoretically and practically of much importance. The work thus breaks a path for biological investigators, engages the interest of the water engineer and the analytical chemist, and brings science and practice into closer relationship. This is the more to be desired since certain problems created by bacteria cannot be satisfactorily solved except by studying the organisms themselves. These are intimately described, the chief contributions of each country to the subject are indicated, and the photomicrographic plates are sufficiently large, clear and typical to enable the student to identify the various bacteria under a high power microscope.

THE VOYAGE OF A VICE-CHANCELLOR. By Arthur Everett Shipley, F.R.S., Sc.D. New York: G. P. Putnam's Sons, 1919. 8vo.; 181 pp.

The British University Commission visited the United States in the fall of 1918, at the invitation of our Council of Defense. To the distinguished scholar who headed this Commission we are indebted for these shrewd, kindly, and humorous extracts from his private diary; they deal with the human side of American life and touch but lightly upon education: this omission is remedied by the concluding paper on "University Education in the United States," a serious summary of its distinctive features, contrasted and compared with those of British institutions. Through it all we get an impression of new friendships made and old ones cemented that augurs well for future understanding and coöperation between British and American culture.

SCHOOL OF PRACTICAL ELECTRICITY. Book I.—Fundamentals of Electricity and Wiring. Milwaukee: Electroforce Publishing Company. 8vo.; 60 pp.; illustrated.

This set of text-books, to judge by the first volume, is well-suited to the home student preparing himself as electrician or electrical engineer, or for use as laboratory manuals and an aid in the solution of every-day problems. Book I. combines both theoretical and practical considerations, covering the fundamentals of bell circuits, telegraph and telephone systems, and the installation of bells and annunciators. Crisp questions and pertinent problems provide means for the student to determine his rate of advancement.

MAKING THE FARM PAY. By C. C. Bowsfield. Chicago: Forbes and Company, 1919. 8vo.; 311 pp.

The second edition of this meritorious work shows wholesale revision of the material dealing with commodity prices and acreage earnings. The principles of intensive farming are simply explained: it makes clear to the farmer his important relation to our broader national life, brings to him the latest agricultural developments and methods, and not only teaches him how to make more money, but how to increase his income and his happiness at the same time. The prospective land owner will find substantial help in its pages, and it has been authoritatively recommended for school use.

FIRE COLLEGE EXTENSION COURSE. By Acting Deputy Chief James A. Heffernan, N.Y.F.D., and Deputy Chief George J. Kuss (Retired), N.Y.F.D. New York: Civil Service Chronicle. 8vo.; 247 pp.; illustrated.

Supplementing "Fire Department Promotion," this excellent text gives the complete official instruction offered by the New York Fire College to firemen and engineers preparing for promotion to lieutenant; it answers civil service examination questions for promotion to deputy chief, battalion chief, captain, and lieutenant, with specimen questions from Seattle, San Francisco, Newark, Chicago, Philadelphia, and Milwaukee. Mention must be made of the description, with 233 drawings especially made by Frederick Lehman, of every tool in use in the New York Department. It is a thorough and comprehensive aid almost indispensable to mastery of the subject, and will save the ambitious man much time and effort.

PROBLEMS OF COSMOGONY AND STELLAR DYNAMICS. By J. H. Jeans, M.A., F.R.S. London: Cambridge University Press. New York: G. P. Putnam's Sons, 1919. 8vo.; 293 pp.; illustrated.

Progress in cosmogony, as Darwin intimated, waits on a determination of the figures of equilibrium of rotating gaseous masses. This prize essay seeks to extend the researches of such thinkers as Darwin, Kelvin and Poincaré and to provide a skeleton of mathematical truth with the behavior of rotating masses as a backbone. Believing, with Herschel, that conjectural concepts, when in accordance with observed facts, have their distinct uses, the author proceeds to certain speculative conclusions toward which his mathematics seems to point. The various hypotheses are in turn considered, and the strength of the work lies largely in its impartial weighing of the advantages and disadvantages of the different theories.